INTERNATIONAL

Marine Engineering

Volume XXV MARCH, 1920 Number 3

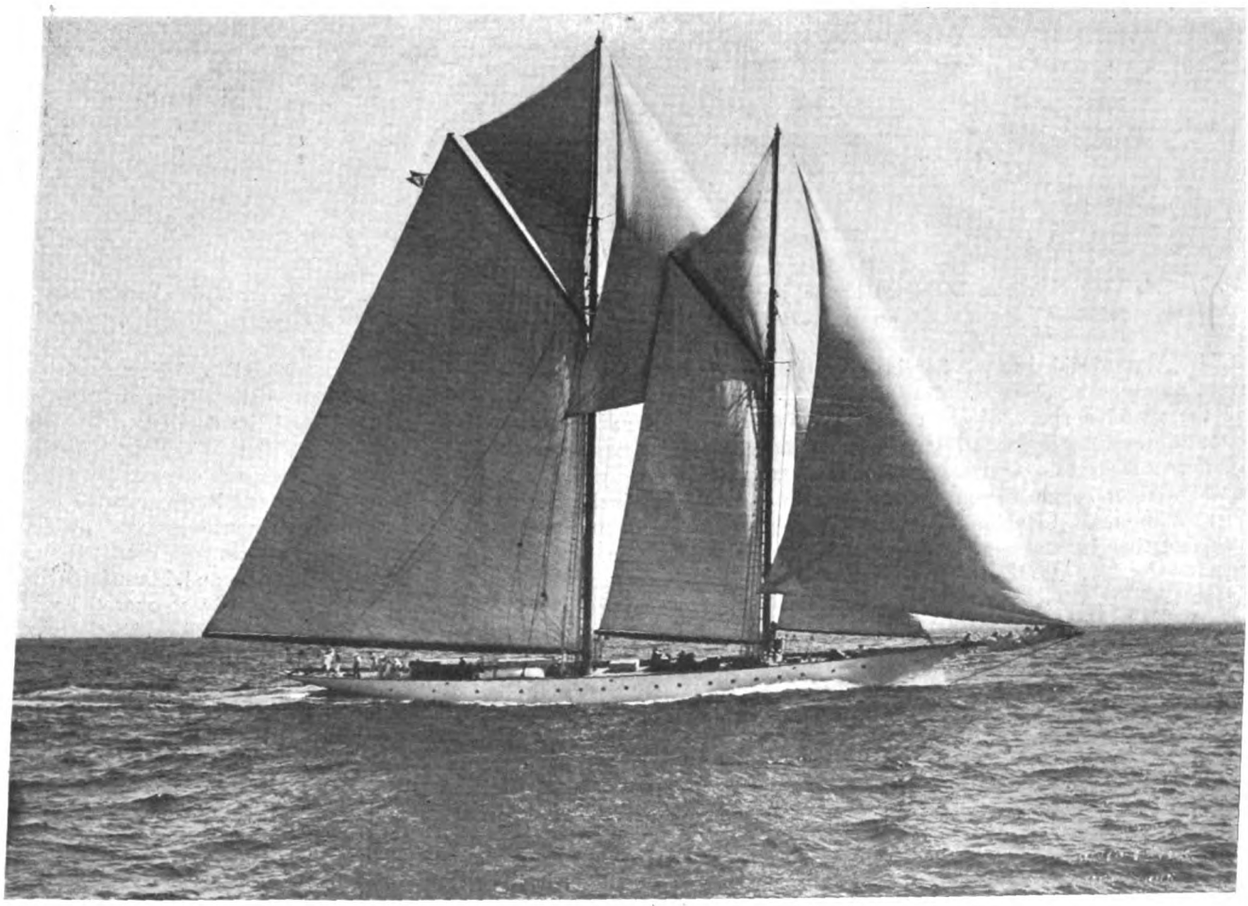

Fig. 1.—Schooner Yacht *Elfay* (formerly the *Katoura*) Fitted with Diesel Electric Auxiliary Power

Diesel-Electric Drive for Yacht Elfay

BY REX W. WADMAN

For a long time the merits and demerits of electrically driven ships have been discussed and many theories have been expounded touching on the efficiency, convenience and dependability of electric drive in comparison with other propulsive powers. It has remained, however, for Mr. Russell A. Alger, of Detroit, Mich., to put these theories to definite trial on a large scale in the field of yachting, and this article briefly describes the equipment and operation of the first Diesel electrically-driven yacht in the world.

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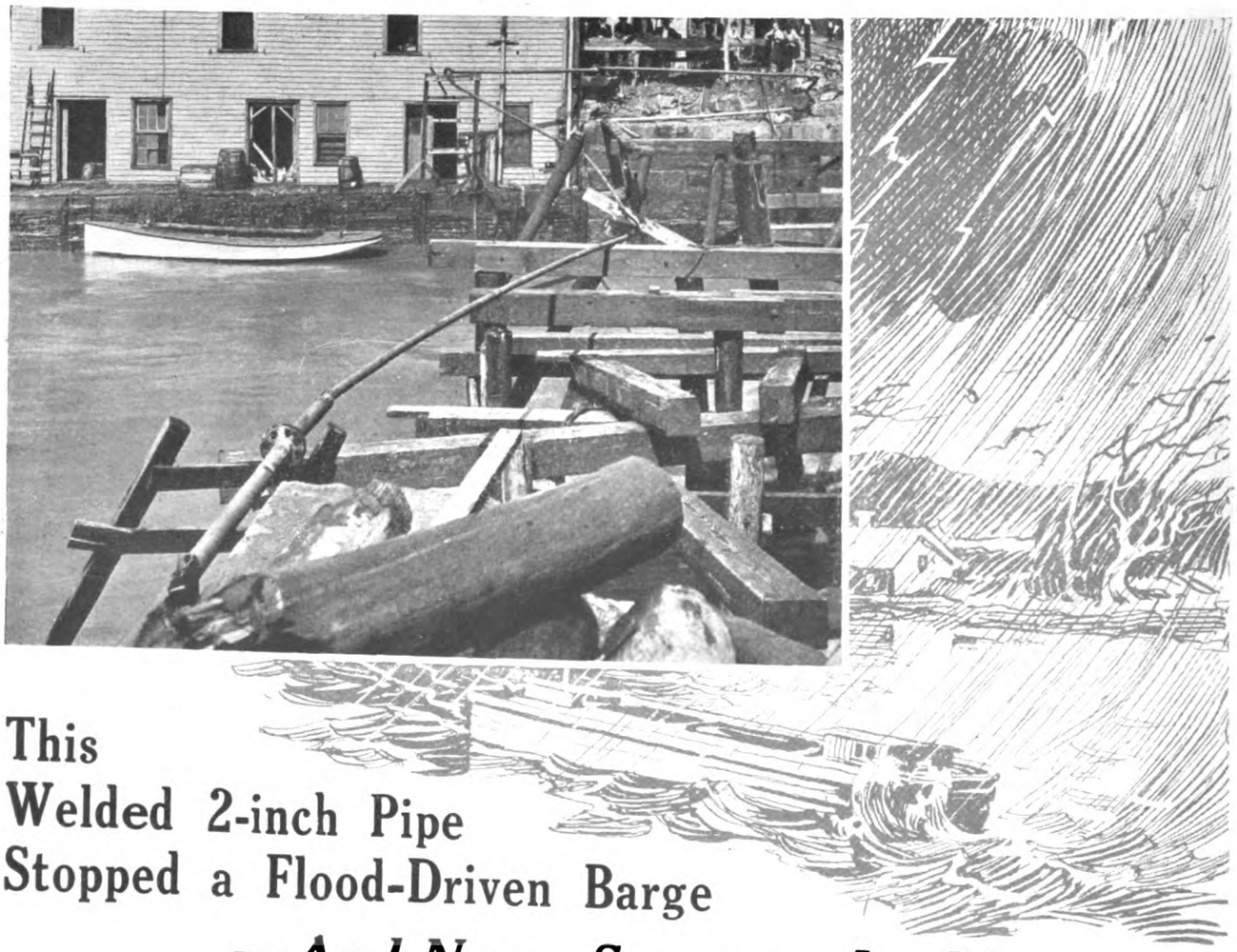

This Welded 2-inch Pipe Stopped a Flood-Driven Barge

—*And Never Sprung a Leak!*

TO MEET a temporary situation, the load from a 6-inch high pressure gas main was put through this welded 2-inch pipe line, laid on temporary piling across a river.

Floods came, washed away the false structure of a new bridge, tore a barge loose from its moorings and hurled the entire mass down on this slender 2-inch pipe.

It held them all. Not a single leak developed.

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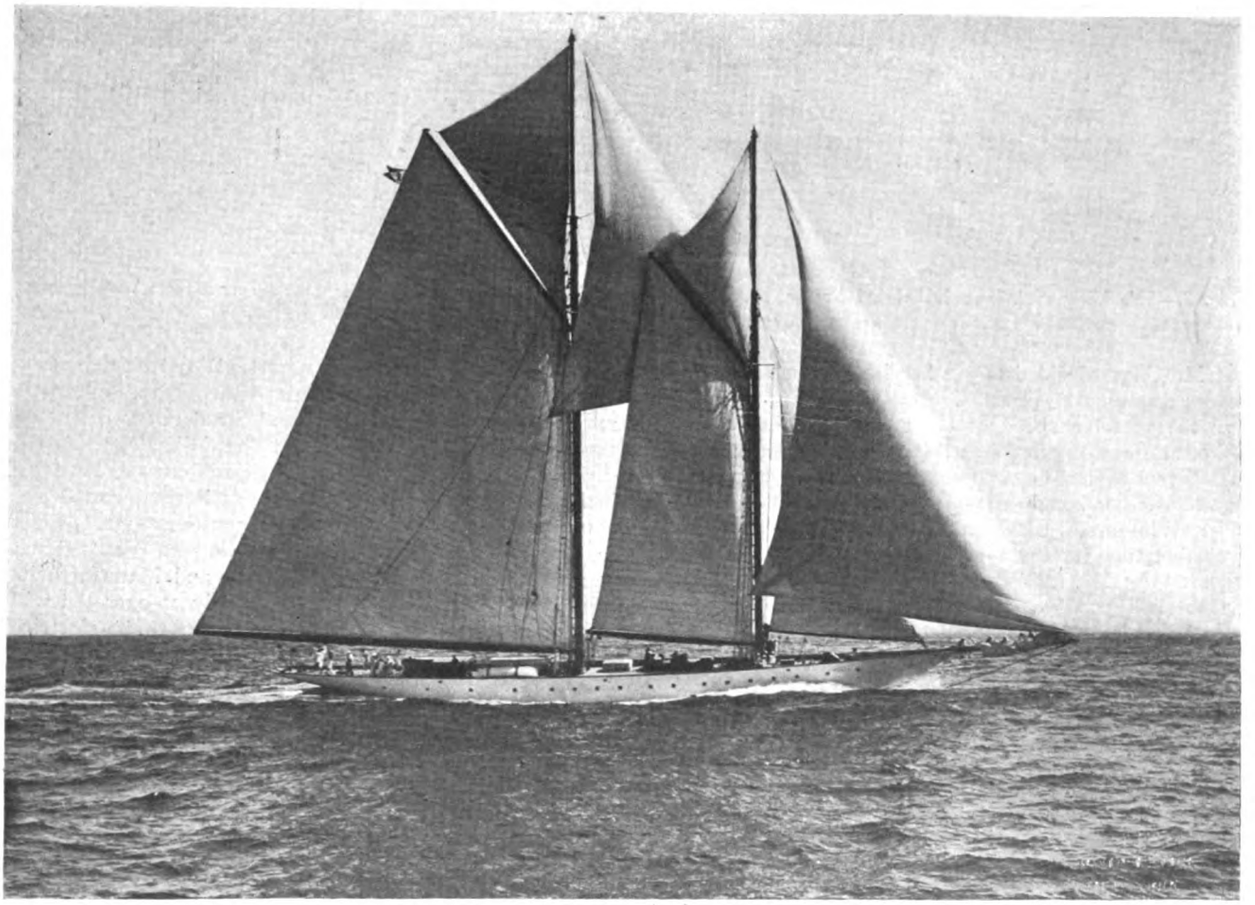

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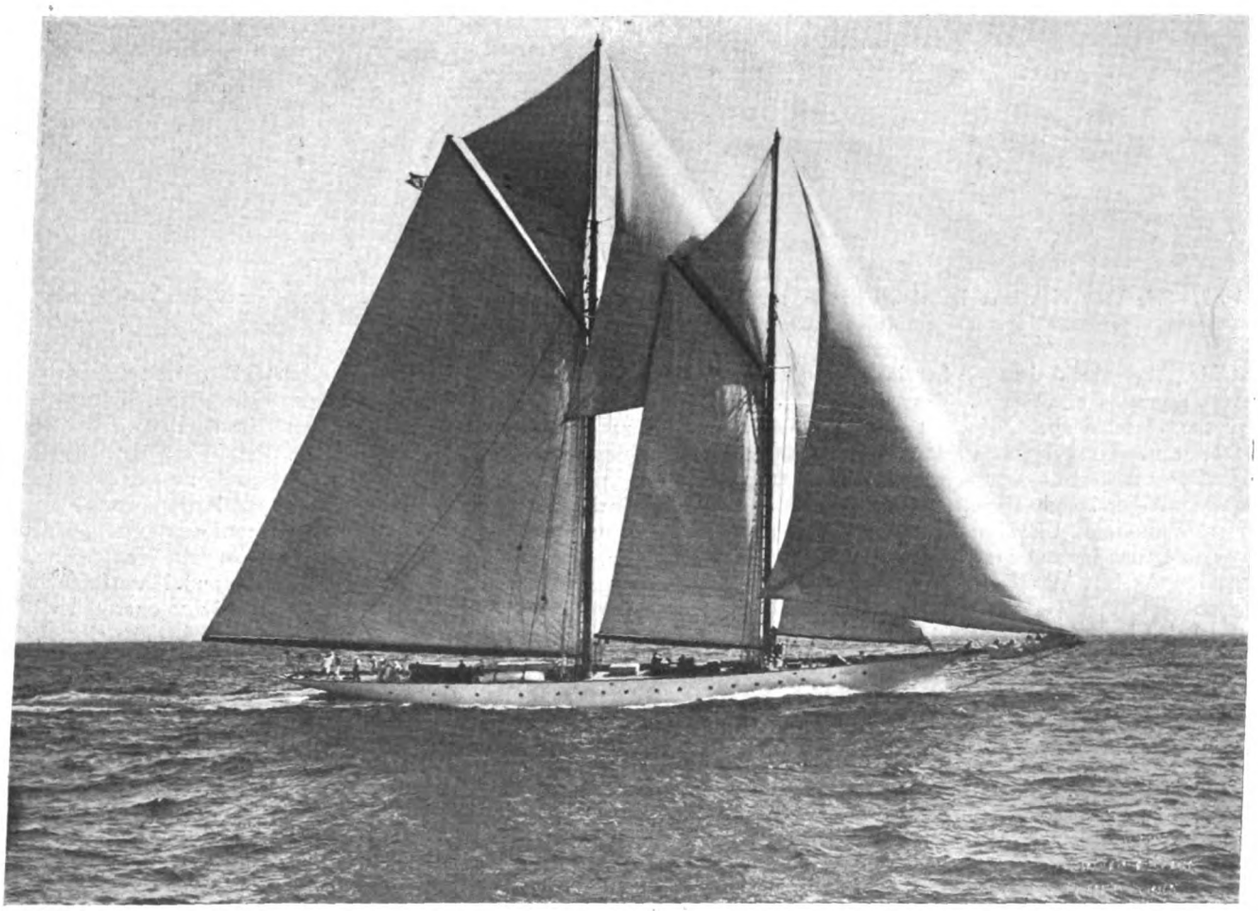

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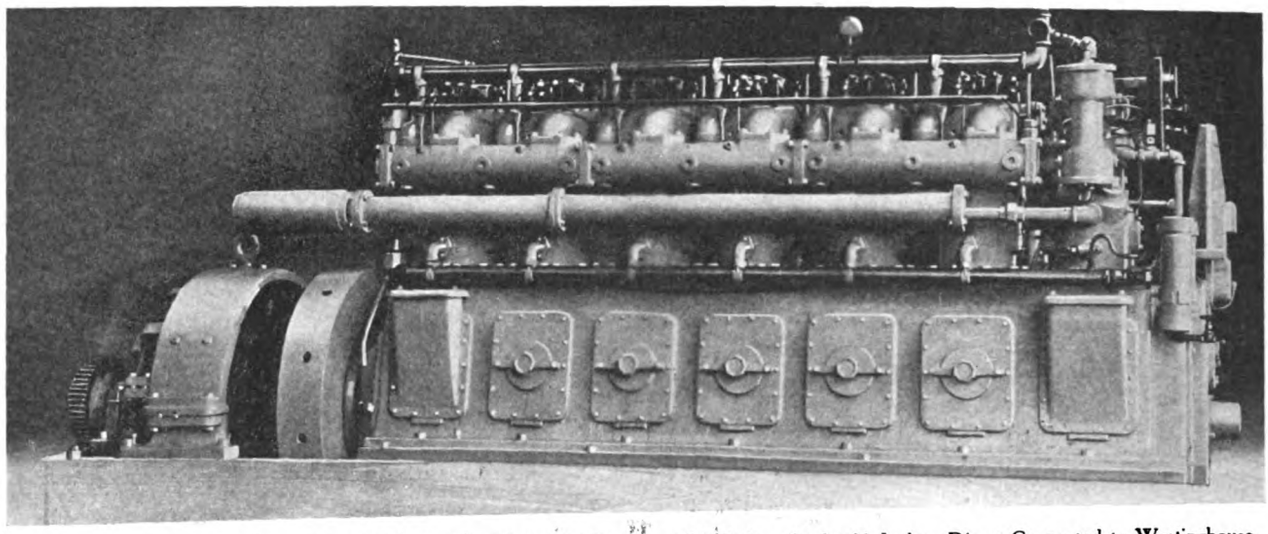

Fig. 2.—Side View of Winton Diesel Oil Engine, Model W-54, Bore 7½ Inches, Stroke 11 Inches, Direct-Connected to Westinghouse Generator as Installed in the *Elfay*

that Mr. Alger decided to put her into commission again. Before doing so he planned to install sufficient power to give the vessel a speed of eight or nine miles an hour without sail. To accomplish this result Mr. Alger decided on rather a radical departure. Away back in ancient history Mr. Alger bought the first 2-cylinder car that Alexander Winton, of Cleveland, built for the market, and since that time he and Mr. Winton have been very close friends. As Mr. Winton has often talked to him about the possibilities of electric drive for yachts, it was but logical that Mr. Alger should be again the first man actually to purchase from Mr. Winton the latest of his innovations.

Mr. Winton and his engineers were given practically carte blanc to work out a complete Diesel electric drive for the *Katoura*, now rechristened the *Elfay*, and as the result of the plans drawn up and the details worked out the installation now consists of the following: A six-cylinder Model 54 Winton Diesel oil engine, bore 7½ inches, stroke 11 inches, rated at 115 horsepower, direct-connected to a 75-kilowatt Westinghouse generator, which in turn is direct-connected to a 9-kilowatt Westinghouse exciter. The Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., actively co-operated with Mr. Winton and his engineers in developing the electrical part of the installation, and a great deal of credit must be extended to the Westinghouse people for the very complete and efficient manner in which their part of the installation was carried out.

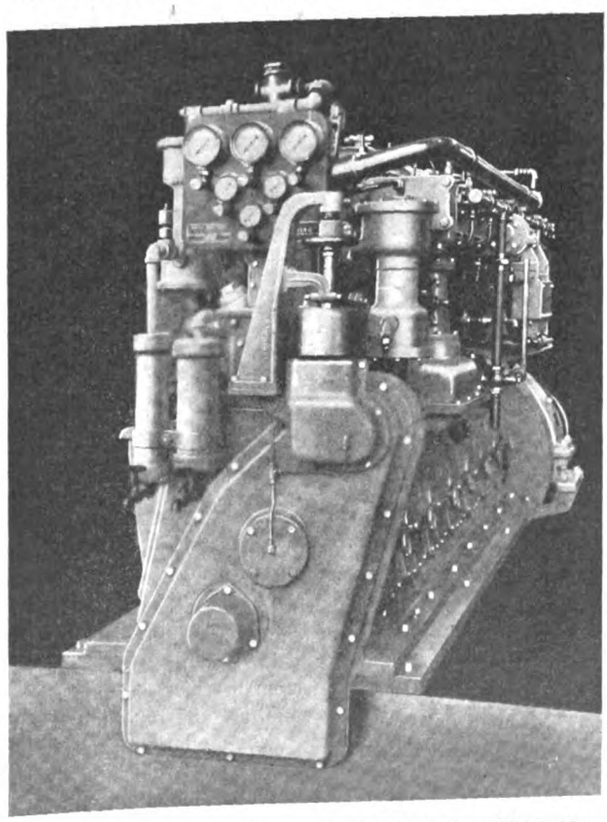

Fig. 3.—End View of Winton Diesel Oil Engine Which Was Installed in the *Elfay*

With the Winton Diesel oil engine and the Westinghouse generator as a nucleus, this entire ship is operated and controlled by electricity; no steam whatever is used or is required.

Electrically-Driven Auxiliaries

The big winch up forward, used for handling the anchor and in case of necessity for handling the sails, is operated by a 10-horsepower electric motor. Amidships two additional electric winches of 4 horsepower each are used for hoisting and lowering the sails. The boat throughout is heated by electricity, lighted by electricity and all cabins, etc., are supplied with electric fans. A ½-kilowatt wireless set is installed aft. Down in the engine room everything is operated electrically. There is a one-ton ice machine operated by a 7½-horsepower electric motor, a water pump, a bilge pump, and an oil pump all electrically driven, a ¾-horsepower air pump supplying fuel to the oil range in the galley, and an electrically-operated grinder and drill for necessary repair work. All bilges are kept ventilated by electrically-operated motors. The engine room itself is ventilated by a 1-horsepower electrically-operated fan. The Model W-18 Winton air compressor in the engine room is likewise operated by a 12½-horsepower electric motor.

In addition to the main generating plant there is an auxiliary generating set consisting of a 25-horsepower Quayle oil engine connected to a 15-kilowatt generator. This is purely an auxiliary outfit used to charge a set of Philadelphia storage batteries when the boat is lying at dock for any length of time.

The installation of storage batteries is a very elaborate and complete one and gives a rated capacity of 60 amperes

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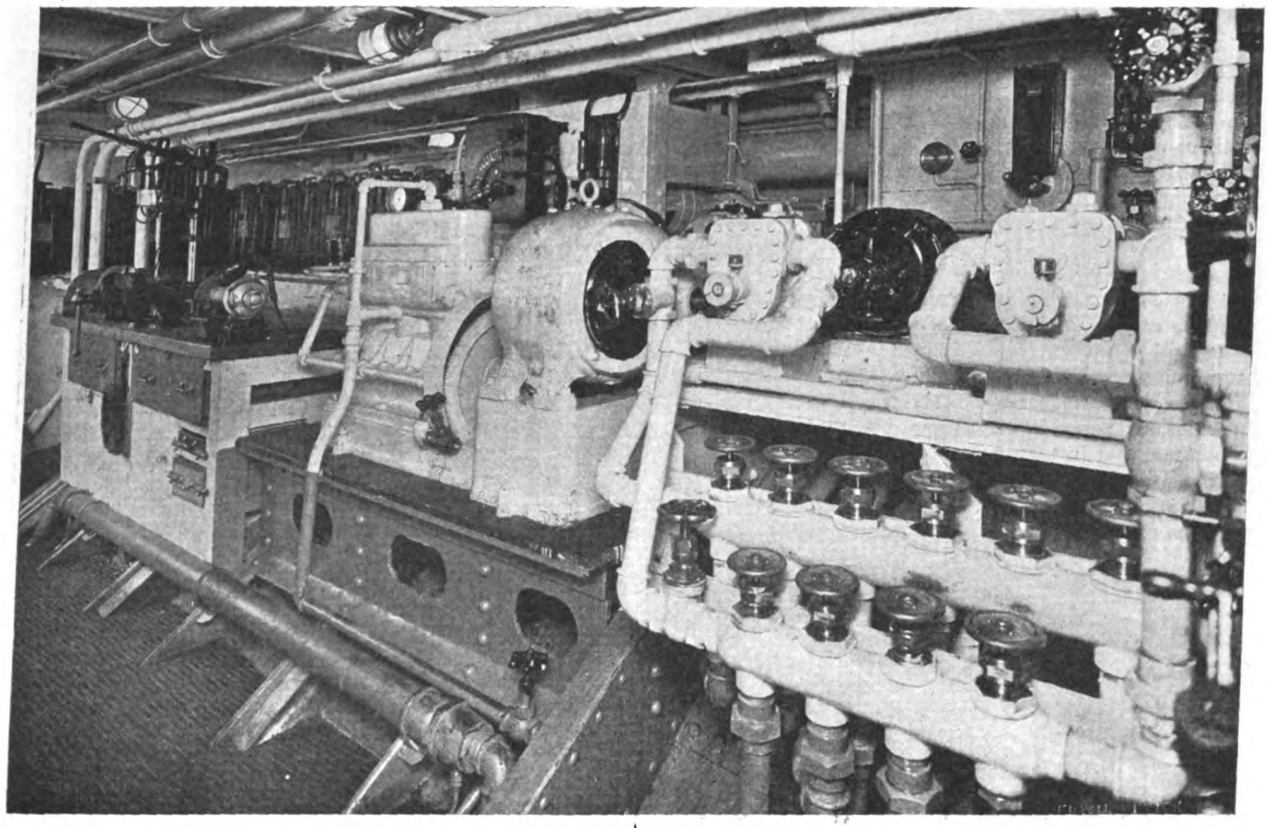

Fig. 4.—Electrically-Driven Auxiliaries in the Engine Room Include Oil Pump, Water Pump, Bilge Pump and Model W-18 Winton Air Compressor. Work Bench Fitted with Electrically-Driven Grinder and Drill. Installation of Philadelphia Storage Batteries in the Rear

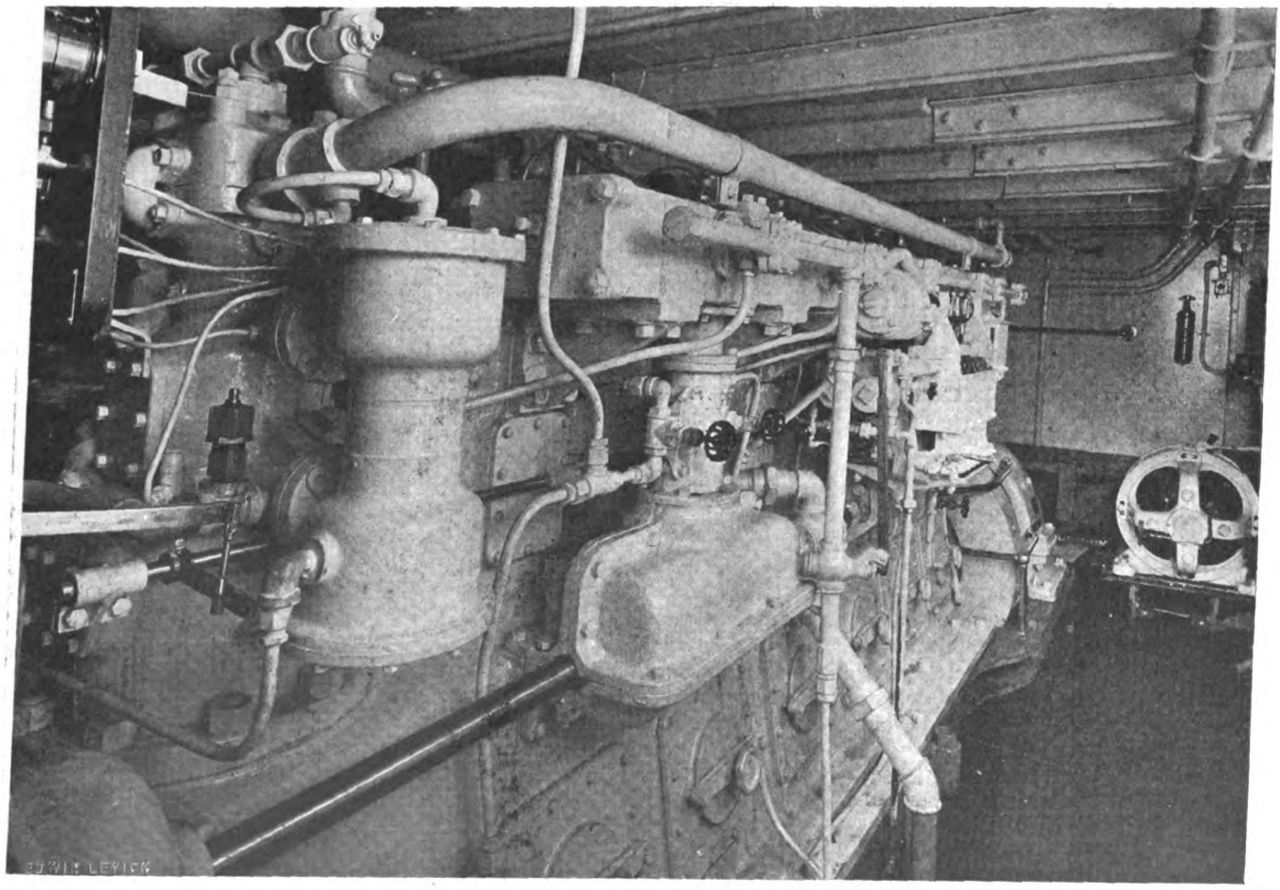

Fig. 5.—Engine Room, Showing Winton Six-Cylinder Diesel Oil Engine Direct-Connected to Westinghouse Generator with Chain-Driven Exciter to the Right. The Whole Engine Room Is Finished in White and the Entire Lack of Grease or Oil Presents a Striking Contrast to the Usual Ship's Engine Room

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an hour for five consecutive hours. All requirements of the boat outside of the actual propulsion through the water can be supplied by this battery for two complete days without recharging.

At this point in the article it may be of value to repeat verbatim a report made to the owner by J. S. Walters, chief engineer of the *Elfay:*

THE CHIEF ENGINEER'S REPORT

"The electric drive as installed on the schooner *Elfay* consists of one 125-horsepower Winton Diesel engine and electrical equipment supplied by the Westinghouse Electric and Manufacturing Company. The engine is of the full Diesel type, four-cycle, six-cylinder, running at 425 revolutions per minute, equipped with a very sensitive governor that in turn controls the amount of fuel fed to the engine from an equally sensitive fuel pump.

"These two features are very essential and will hold the engine at almost constant speed under all conditions. In

Fig. 6.—A "Close-Up" of the Control Station. From This Spot the Officer of the Deck Has Complete and Instantaneous Control of the Motive Power

fact, the variation of speed from full ahead to full astern or from full astern to full ahead is about 20 revolutions per minute. This engine is direct-connected to a 75-kilowatt generator and also drives a 9-kilowatt exciter by means of a noiseless chain. The exciter turns at 900 revolutions per minute. The motor and generators are both separately excited from the exciter, the motor carrying a full field at all times. The generator field is strengthened, for going either ahead or astern, from on deck by means of a controller, which is connected to a rheostat below deck.

"In the stop position there is no field in the generator but a full field in the motor; in the full ahead position there is a full field in both, and likewise a full field in both in the full astern position. The speed ahead or astern is varied according to the strength of the field in the generator.

"The exciter has a capacity of 9 kilowatts, and the

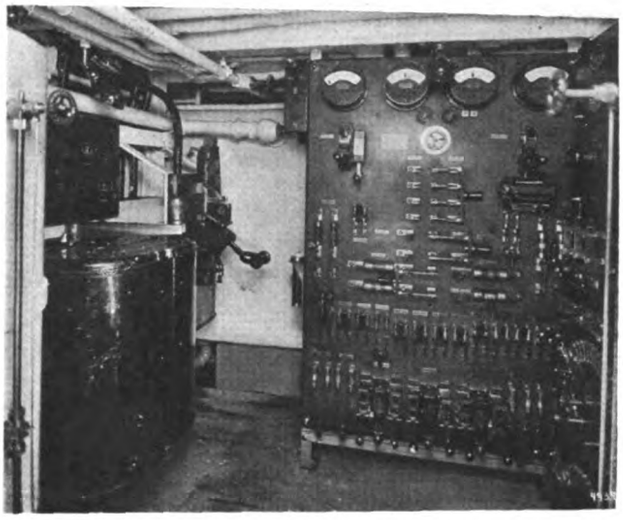

Fig. 7.—The Central Station—A Splendid Example of Electrical Installation and Control Worked Out by the Westinghouse Organization

motor requires about 2 kilowatts, and the generator 2 kilowatts, for excitation, leaving 5 kilowatts for auxiliary purposes, such as lights and power.

"The main motor is installed as far aft as possible, giving a very short shaft. It is 90 horsepower at 360 revolutions per minute, turning a 42-inch by 42-inch three-blade propeller, giving a speed of between 8 and 8½ knots.

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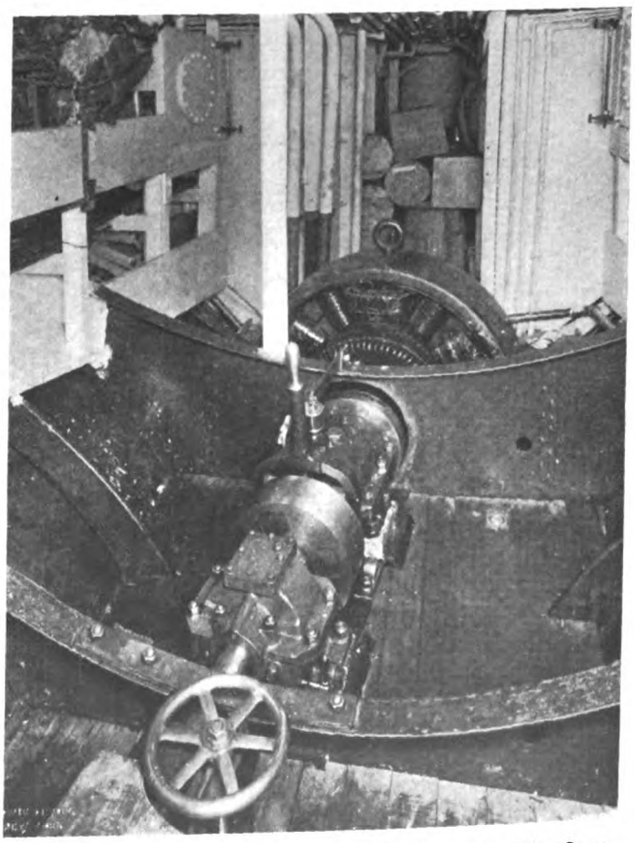

Fig. 8.—The 90-Horsepower Driving Motor Located in the Stern. Note Size of Bearings and Disengaging Clutch

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"The actual operation consists of starting the engine idle, next throw the cam controller switch, building up the motor field from the exciter. Then the main breaker between the cam controller and motor. These are the only connections the engineer makes. The rest is controlled from deck. The deck controller is a small brass stand about 30 inches high. The handle has a swing of about 20 inches. By moving the handle one-half of the circle full ahead is obtained. By moving it the opposite way one-half the circle full astern is secured.

"A metering panel set in the deck house gives the voltage of generator, motor and exciter, the amperes used, also the revolutions per minute of the motor and generator. A duplicate set gives the same information in the engine room. It also indicates ahead or astern motion.

"The officer on deck knows at all times what speed he is making and can get the exact speed or power he wants

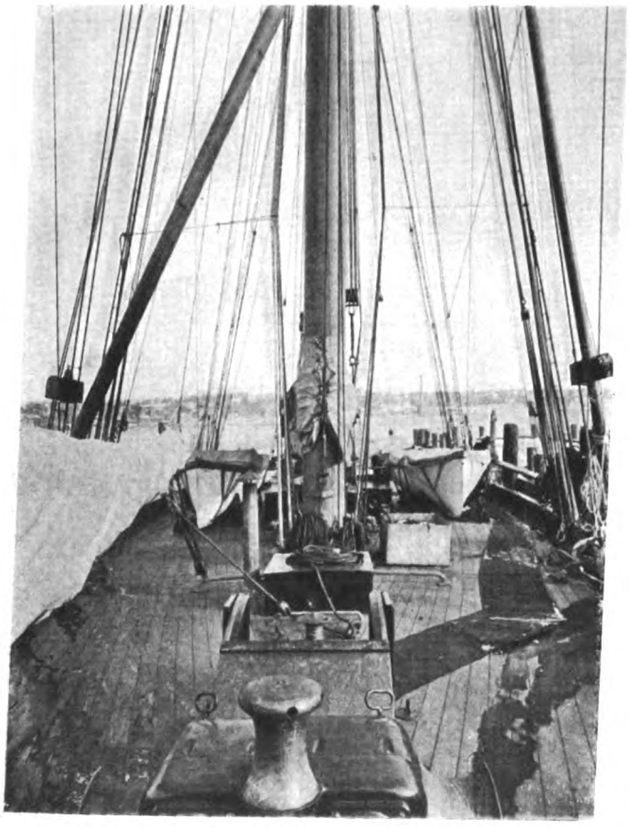

Fig. 9.—Deck and Rigging of the *Elfay*

either ahead or astern when he is in a tight place. He not only has control of the ship, but the control of the power aboard also."

In Chief Walters' report the extreme simplicity of the control in this unique installation made possible by the Diesel electric drive is brought out in detail. The officer on deck himself is in complete control of the power unit. He does not have to rely on signals to the engine room with their necessary delays, etc. In addition, he has as much power available for reversing as he has for going ahead, and all within the uncannily short period of five seconds.

Here is an installation of a Diesel engine using fuel oil—the cheapest fuel obtainable—supplying that most flexible of all propulsive powers—electricity. Here is a compact, efficient, quiet and clean power plant which can be relied upon day in and day out, week in and week out. Such an installation can be operated at a minimum of expense for either fuel or labor as compared with any other type of power installation which could have been made.

The fueling situation is as efficient as is the balance of this remarkable installation. The boat has a capacity of 2,400 gallons of fuel oil, which gives her a cruising radius of 2,000 miles with a consumption of approximately 7½ gallons per hour. In addition, 360 gallons of lubricating oil are carried so that this boat can well be used for a world-wide cruise such as her owner plans to make. In fact, Mr. Alger is now on the way to Cuba, Bermuda, etc., and expects to return to New York in the spring and then plans to go to Europe down through the Mediterranean to the Suez Canal, through the Suez Canal to India, China and Japan and thence back to New York via Australia, Honolulu and the Panama Canal.

Such an installation as he now has in the *Elfay* makes such a trip both possible and safe, and it is not idle prophecy to say that many other yachts will follow the example set by the *Elfay* and will soon be equipped with Winton Diesel electric propulsion. It is interesting to note that efficient as this type of installation is in such a boat as the *Elfay* it is many times more efficient and desirable as an installation in our cargo carriers, where dependability and economy in power are so vitally necessary. In fact, it is a none too well-guarded secret that a number of cargo boats built by the Emergency Fleet Corporation in the hurry-scurry of war requirements are being converted from uneconomical and unprofitable steamers to economical and highly profitable electrically-driven boats, using the same principle of installation as that pioneered by Mr. Alger.

British Destroyer Wivern

Messrs. J. Samuel White & Co., Ltd., the well-known shipbuilders and engineers of East Cowes, Isle of Wight, completed and delivered their one hundred and twentieth steel war vessel and seventy-second steel torpedo craft on December 23. This was H.M.S. *Wivern* of the improved "W" class, which was laid down on August 19, 1918, and launched on April 15, 1919. She is similar in every respect to the *Witherington, Winchester, Vortigern* and *Vectis,* also built by the firm and now serving in the Royal Navy. She is of 1,450 tons displacement and 28,000 shaft horsepower.

The full power trials of the vessel off the south coast of the Isle of Wight were entirely satisfactory, when she attained an average speed of between 34 and 35 knots. The *Wivern's* twin screws are driven by a double set of Brown-Curtis geared turbines made by Messrs. White, and Mitchell thrust blocks have been installed. Steam is generated in three White-Forster watertube boilers. These, together with the oil fuel burning installations, all auxiliary machinery and the entire equipment, have also been constructed in the firm's engine works. The ship is capable of carrying some 400 tons of oil fuel, which will enable her to run about 1,000 miles at full speed.

Like the other destroyers of her class, the *Wivern's* armament consists of superimposed 4.7-inch guns fore and aft, with fire control and director gear, two anti-aircraft, high-angle, quick-firing guns on an elevated platform amidships, and two sets of triple-torpedo tubes mounted on revolving platforms.

As is customary with all White-built destroyers, the living accommodation for officers and crew surpasses that of most destroyers, the firm having consistently made this a special feature of their construction.

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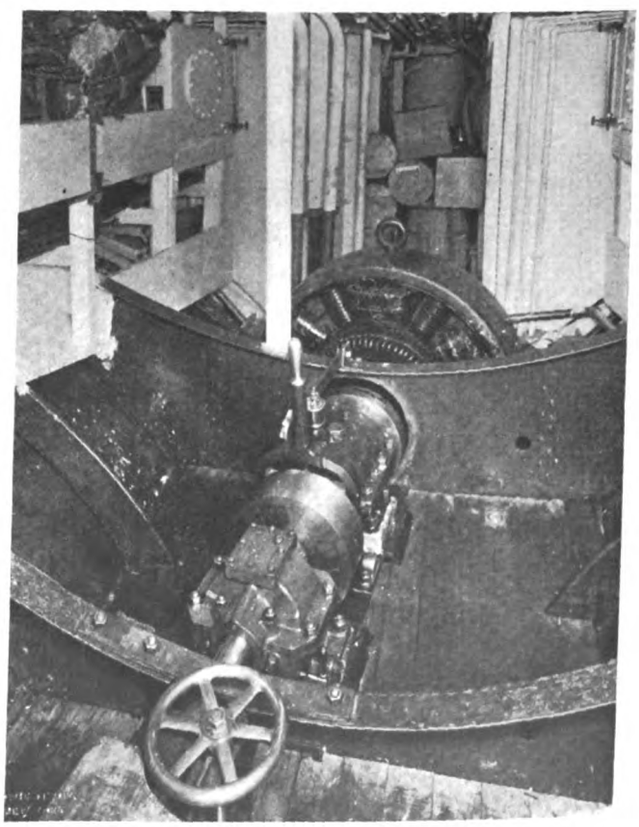

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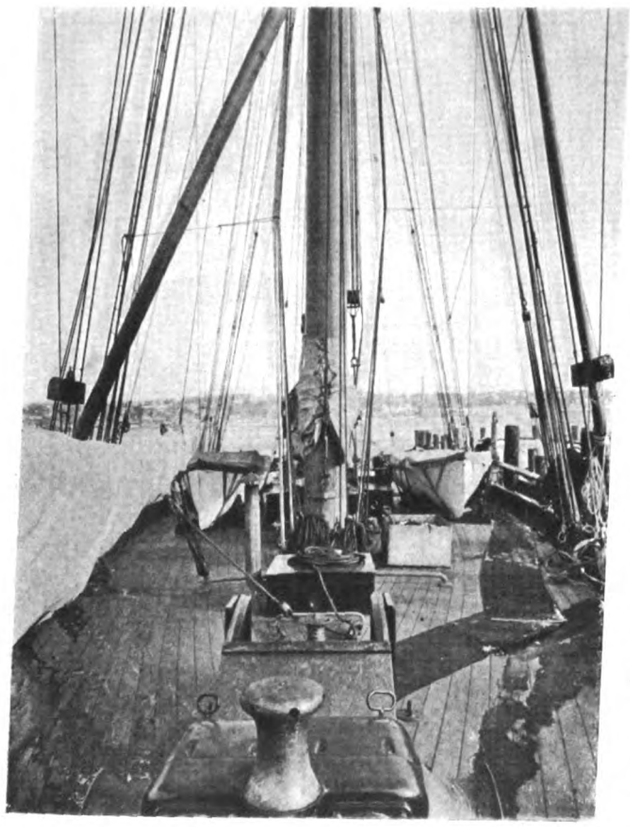

Fig. 9.—Deck and Rigging of the *Elfay*

either ahead or astern when he is in a tight place. He not only has control of the ship, but the control of the power aboard also."

In Chief Walters' report the extreme simplicity of the control in this unique installation made possible by the Diesel electric drive is brought out in detail. The officer on deck himself is in complete control of the power unit. He does not have to rely on signals to the engine room with their necessary delays, etc. In addition, he has as much power available for reversing as he has for going ahead, and all within the uncannily short period of five seconds.

Here is an installation of a Diesel engine using fuel oil—the cheapest fuel obtainable—supplying that most flexible of all propulsive powers—electricity. Here is a compact, efficient, quiet and clean power plant which can be relied upon day in and day out, week in and week out. Such an installation can be operated at a minimum of expense for either fuel or labor as compared with any other type of power installation which could have been made.

The fueling situation is as efficient as is the balance of this remarkable installation. The boat has a capacity of 2,400 gallons of fuel oil, which gives her a cruising radius of 2,000 miles with a consumption of approximately 7½ gallons per hour. In addition, 360 gallons of lubricating oil are carried so that this boat can well be used for a world-wide cruise such as her owner plans to make. In fact, Mr. Alger is now on the way to Cuba, Bermuda, etc., and expects to return to New York in the spring and then plans to go to Europe down through the Mediterranean to the Suez Canal, through the Suez Canal to India, China and Japan and thence back to New York via Australia, Honolulu and the Panama Canal.

Such an installation as he now has in the *Elfay* makes such a trip both possible and safe, and it is not idle prophecy to say that many other yachts will follow the example set by the *Elfay* and will soon be equipped with Winton Diesel electric propulsion. It is interesting to note that efficient as this type of installation is in such a boat as the *Elfay* it is many times more efficient and desirable as an installation in our cargo carriers, where dependability and economy in power are so vitally necessary. In fact, it is a none too well-guarded secret that a number of cargo boats built by the Emergency Fleet Corporation in the hurry-scurry of war requirements are being converted from uneconomical and unprofitable steamers to economical and highly profitable electrically-driven boats, using the same principle of installation as that pioneered by Mr. Alger.

British Destroyer Wivern

Messrs. J. Samuel White & Co., Ltd., the well-known shipbuilders and engineers of East Cowes, Isle of Wight, completed and delivered their one hundred and twentieth steel war vessel and seventy-second steel torpedo craft on December 23. This was H.M.S. *Wivern* of the improved "W" class, which was laid down on August 19, 1918, and launched on April 15, 1919. She is similar in every respect to the *Witherington, Winchester, Vortigern* and *Vectis,* also built by the firm and now serving in the Royal Navy. She is of 1,450 tons displacement and 28,000 shaft horsepower.

The full power trials of the vessel off the south coast of the Isle of Wight were entirely satisfactory, when she attained an average speed of between 34 and 35 knots. The *Wivern's* twin screws are driven by a double set of Brown-Curtis geared turbines made by Messrs. White, and Mitchell thrust blocks have been installed. Steam is generated in three White-Forster watertube boilers. These, together with the oil fuel burning installations, all auxiliary machinery and the entire equipment, have also been constructed in the firm's engine works. The ship is capable of carrying some 400 tons of oil fuel, which will enable her to run about 1,000 miles at full speed.

Like the other destroyers of her class, the *Wivern's* armament consists of superimposed 4.7-inch guns fore and aft, with fire control and director gear, two anti-aircraft, high-angle, quick-firing guns on an elevated platform amidships, and two sets of triple-torpedo tubes mounted on revolving platforms.

As is customary with all White-built destroyers, the living accommodation for officers and crew surpasses that of most destroyers, the firm having consistently made this a special feature of their construction.

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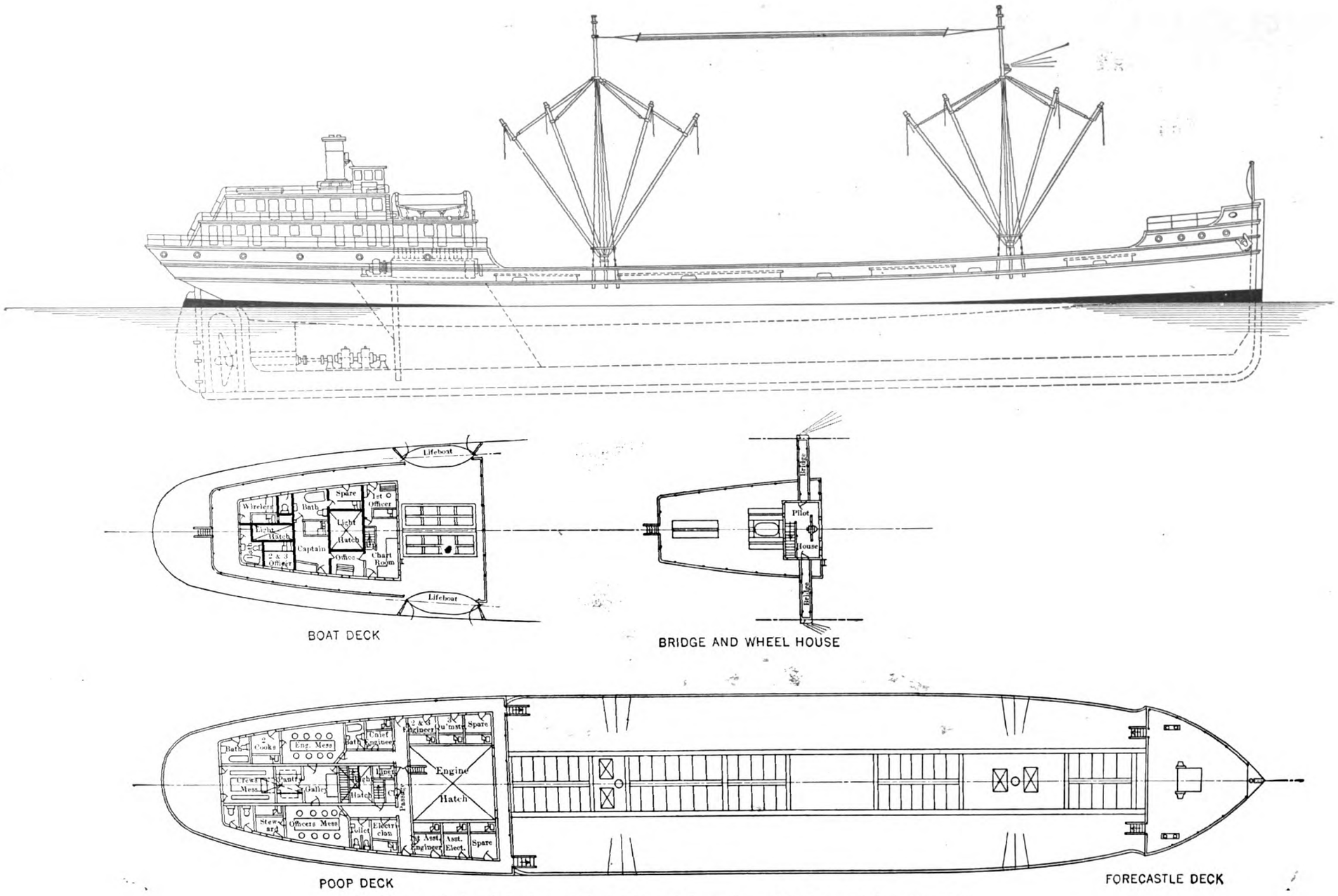

Fig. 1.—Outboard Profile and Deck Plans of Ferris-Type Hull Converted Into Motorship

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Converting the Ferris-Type Wooden Hulls Into Diesel-Electric Driven Motorships

BY RENWICK Z. DICKIE*

The United States Shipping Board is offering many Ferris-type hulls at an attractive price and many shipping men are interested. This proposed Diesel-electric drive provides a very satisfactory method of converting these hulls into economical and reliable motorships.

FROM a shipowner's point of view the value of a vessel is decided by what she can earn as an investment. To analyze this value it would be necessary to consider the original cost, reliability of the hull and machinery, the maximum economical speed, the largest amount of cargo that can be carried, and, also, the question of easy loading and discharging and the economical operation with a large cruising radius.

In order to obtain the services of the best men for the operation of a ship, it is necessary that the officers', engineers', and crew's accommodations be of the best, so that the men who operate the ship will look upon her as their home, especially when the vessel is adapted to long cruises.

From the operating engineer's point of view, the engine room should be light and airy for comfortable work.

The Winton Engine Works, of Cleveland, Ohio, in collaboration with the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has taken up the matter of a Diesel-electric drive and is manufacturing direct-connected stationary engines for this purpose which are light enough to allow the main power plant of the vessel to be placed on deck. As many units are used as are necessary for the power required, and engine parts would be interchangeable, so that only one set of spares need be carried.

In the Ferris type of hull there is between the top of the keelson and the center of the propeller shaft a distance of only three feet, and with this fixed distance a motor with an external diameter of six feet only can be used. Such machines can be built for direct connection to the propeller shaft, or, if higher speed motors are desired, they can be used with gearing. The use of gearing may slightly reduce the weight, but, on the other hand, it is an additional piece of apparatus that requires attention. It is considered that good engineering requires the simplest possible operating equipment, and the use of a direct-connected motor is proposed. Provision would be made to facilitate the removal of the tail shaft by simply raising the top of the motor casing and the armature.

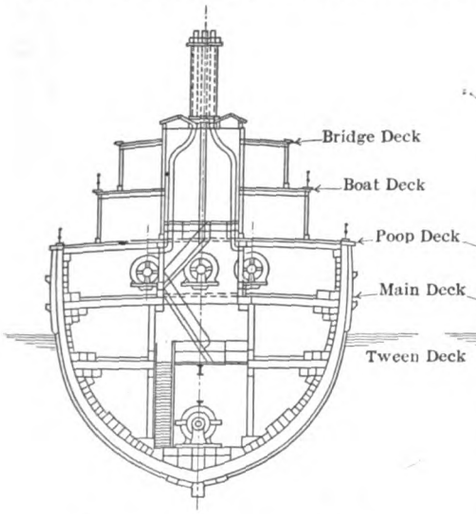

Fig. 2.—Section Through Motor Room

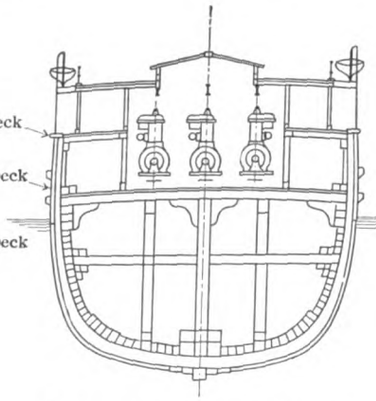

Fig. 3.—Section Through Engine Room

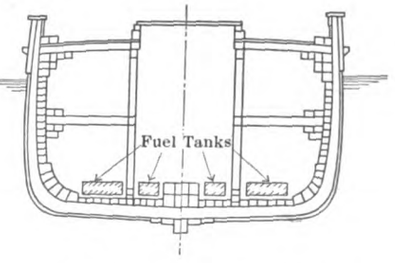

Fig. 4.—Section Through Cargo Hold

Alternating vs. Direct Current

In the case of electric marine drive with a steam turbine as a prime mover, alternating current has been used for transmitting the power from the generators to the driving motor. In case of high-powered installations, this system has advantages, and if turbines are used we are practically limited to it by the fact that direct-current generators cannot be built to run at the speeds required for turbine economy. In the case of Diesel engines, the speed of the prime movers favors direct-current generators, and the requirements of low-speed propelling motors present no difficulty, whereas with alternating current the slow-speed propelling motor is very difficult to build and does not contain desirable characteristics. The use of direct current eliminates any necessity of varying the speed of the prime movers and it makes possible the utilization of the full power of the engines, independently of the speed of the propeller. With an installation using three generators, for instance, one might be shut down and the motor then run at the proper speed to give two-thirds power, whereas with alternating current the speed of the prime movers would have to be reduced and this would, of course, proportionally reduce the available power.

With direct current the speed of the motor can be varied anything from zero to the maximum required revolutions and in either direction by simply regulating the field of the generators, and it will not be necessary to handle the main

* Naval architect, San Francisco, Cal.

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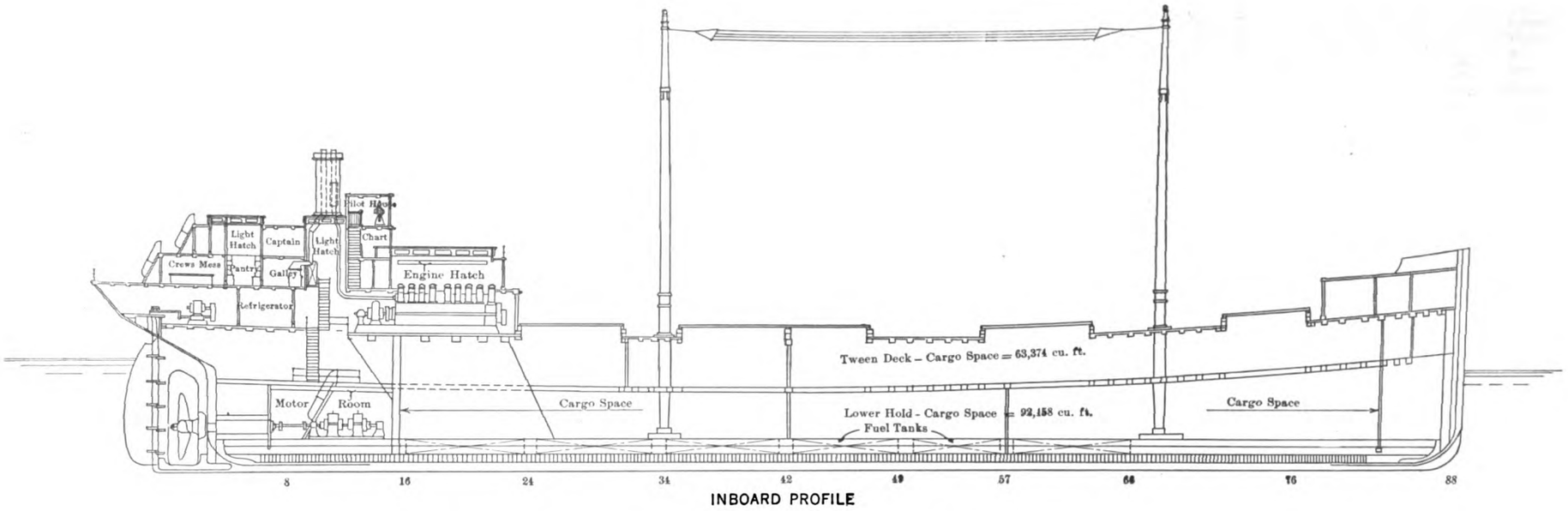
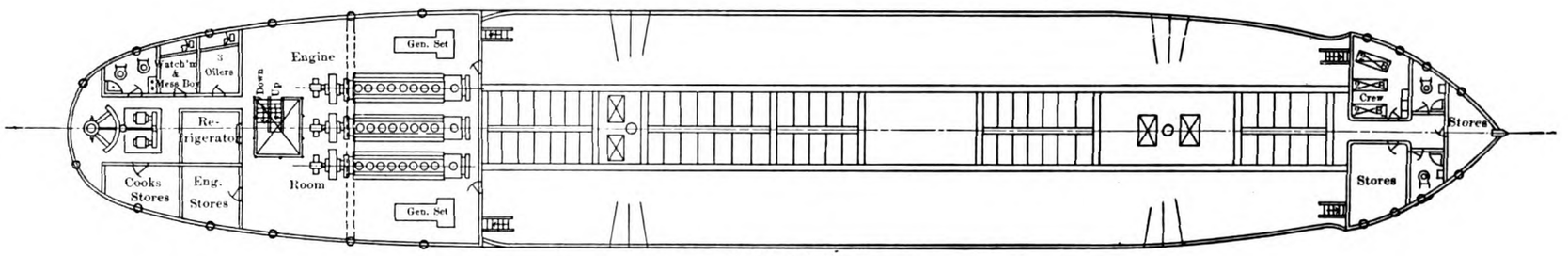
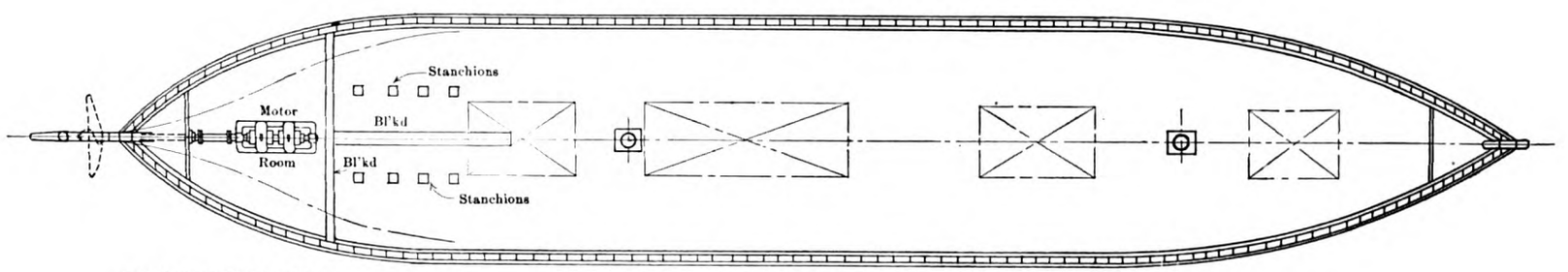


INBOARD PROFILE



MAIN DECK



PLAN OF MOTOR ROOM

Fig. 5.—Inboard Profile and Deck Plans, Showing Machinery Arrangement of Converted Ferris-Type Hull

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current. Due to this characteristic, the controlling equipment is very small and of light weight and can be located anywhere that may be convenient and be operated from the pilot house if so desired.

It may be objected that machinery using direct current is not as reliable as that using alternating current. In this connection it may be pointed out that in some of the most important electrical applications where reliability is of the utmost importance, direct current is applied, as, for instance, reversing blooming mills in steel plants, where machines capable of carrying loads up to 20,000 horsepower are in daily use, and in the use of high-powered electric locomotives such as are used in the Pennsylvania tunnel in New York and also on the Chicago, Milwaukee & St. Paul mountain division.

DIRECT CURRENT FOR AUXILIARIES

Direct current offers easy control and there are many advantages in its use for auxiliary machinery. Westinghouse experts propose its use with a complete electrical installation for all engine room auxiliaries and deck machinery, so controlled and wired that any one of the three main driving units may be used while in port to furnish all the power necessary for the operation of cargo winches and windlasses. Some time ago a test was made to ascertain the cost of fuel for handling 1,000 tons of cargo; using coal, it was $12, oil $7, and electric current $2.

In comparing this electric installation with propulsion by steam, it is assumed that two first-class electricians can properly care for the plant, and that their wages would just offset the wages of the firemen in the steam plant.

Figs. 1-5 illustrate a Ferris hull plant of this type, with the engines placed on deck, supported by a heavy centerline and 'thwartship bulkhead just forward of the motor compartment, leaving almost the entire hold space for cargo. The fuel tanks could be placed alongside of the keelson the entire length of the ship, giving a decided advantage in trimming when the ship is running light.

COMMERCIAL GAIN OF DIESEL-ELECTRIC DRIVE

In order to illustrate the commercial gain of a Diesel-electric drive, placed in a wooden Ferris hull, a comparison will be given between two ships of this type, operating on the west coast, using available freight rates and charges, one vessel being equipped with a steam oil-burning plant with 1,400 indicated horsepower, and one equipped with an electric plant, giving the same effective horsepower at the propeller.

The Ferris type ships have a length overall of 281 feet 6 inches, a length between perpendiculars of 268 feet, a beam of 46 feet, and a depth of 26 feet. For comparison we will take the Ferris ship with watertube boilers and a triple-expansion engine with cylinders 19 inches, 32¼ inches and 54 inches diameter by 42 inches stroke, operating at 90 revolutions per minute.

CARGO-CARRYING CAPACITY

Former operators of these vessels say that as coal burners they carried cargoes varying from 2,700 to 3,000 tons, but with oil they should carry at least 3,400 to 3,600 deadweight tons with the same cruising radius and have a sea speed of ten knots. As coal burners they have averaged between eight and nine knots, as in many instances they were hard steamers; but, as it requires less heating surface for oil, this defect would probably be remedied and they could be operated fairly economically.

Owners operating vessels of this size on the west coast have gone through their books and made a statement of value per deadweight ton for the last year, which is based on the total amount of freight carried, the amount received for this freight, and the expense of operating a ship of this size as an oil burner over a period of one year. By the following data it will be seen that by installing the proposed electric drive a saving of 80 tons in the original machinery weight would be effected, and 220 tons of oil would easily give the vessel the same cruising radius.

	Diesel Electric Drive	Triple-Expansion Plant
Indicated horsepower	1,400	1,400
Weight of plant installed, tons	220	300
Fuel used per hour per horsepower pounds	.45	1.25
Fuel used per hour, barrels	1.9	5.4
Fuel used per day at sea, barrels	45.6	129.6
Fuel used per day in port, barrels	8	26
Lubricating oil per day at sea, gallons	40.3	7
Lubricating oil per day in port, gallons	8.4	3
Lubricating oil per year in barrels	278.2	52
Cost lubricating oil per gallon	$0.29	$0.43
Cost lubricating oil per year	$3,338.40	$939.00
Cost of fuel oil, per barrel	$1.85	$1.60
Cost of fuel oil per day at sea	$87.32	$207.36
Cost of fuel oil per day in port	$14.80	$41.60
Days at sea	270	270
Days in port	95	95
Water used per day for power plant, tons	...	3.75
Fuel used per day, tons	6.74	18.64
Weight of fuel carried, tons	220	650
Weight of water carried, tons	50	170
Cost of water per ton	$1.00	$1.00
Cargo carried in deadweight tons, tons	3,400	3,000
Cargo space, in cubic feet	155,832	116,000
Cargo space (40 cubic feet per ton), tons	3,900	2,900
Fuel used in one year, barrels	13,504	37,462
Water used in year for power plant, tons	.....	1,125
Total cost of fuel, water and lubricating oil for one year	$28,321.40	$62,004.12
Net profits of ship based on steam plant economy at $50 per deadweight ton	$170,000.00	$150,000.00
Total net profits, including fuel saved	$203,682.72	$150,000.00

Over a period of a year in the operation of the vessel, taking the present cost of fuel and water, she would have an increased carrying capacity of 400 tons, and would net her owners about $56,082 additional, through the saving in coal, water and weight, or a net gain in the commercial efficiency of the ship of about 35.7 percent.

American Progress in Marine Refrigeration

BY J. F. FARISH

UNTIL five or six years ago very little had been done in this country in refrigeration of ships for meat carrying, although this class of work was well advanced in Europe. After the great war began it was found that ships capable of carrying cargoes of meat were in demand. The European plants, usually sought for the work, were busy on war work and America was looked to. The first fully-fitted ship to be completely insulated and fitted with machinery was completed in Brooklyn for the Italian Government. When the United States entered the conflict it was found that refrigerator ships were lacking. By this time a number of foreign ships had been changed to American registry, and the only refrigerated ships flying the Stars and Stripes were fruit carriers and one or two tramps that had been converted to meat boats for the South American trade by private owners.

MEAT CARRIERS FOR THE ARMY IN FRANCE

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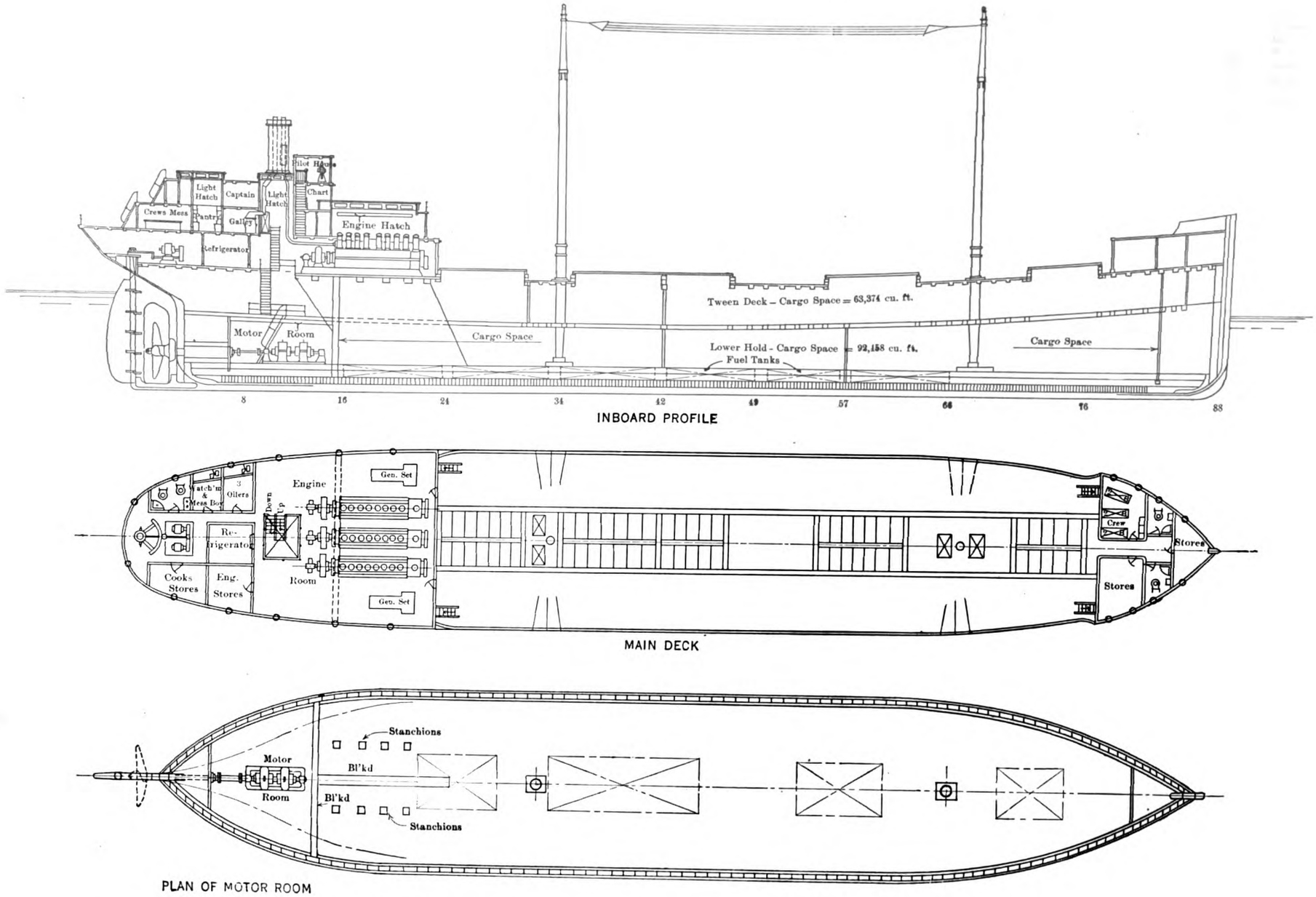

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given over to the refrigerating engineers, with the result that the United States produced meat carriers equal to, if not surpassing, those put out by our Allies.

To convert a regular cargo ship into a meat carrier requires several months. It has been the practice of the Shipping Board to install two or three steam-driven machines, each of fifty tons capacity, on a ship, according to the space refrigerated. On a few of the ships ammonia, which is almost exclusively used ashore, was used, but in the majority of cases CO_2 (carbon dioxide) machines were installed. While the working pressure necessary for ammonia is less than 200 pounds as compared to 1,200 pounds for CO_2, the danger of a leak in the system and injury from ammonia fumes is greater than with CO_2. From a standpoint of safety to the engine room crew, and consequently to the ship herself, CO_2 installations find much greater favor among marine engineers and architects.

Refrigerating System

The refrigerating system on a meat carrier consists of the machine, or compressor, which is the heart of the plant, and the cold compartments where the meat is stored. Connecting these sections and completing the arrangement are condensers, pumps, coolers, tanks and several miles of piping, which covers the meat compartments completely on the side walls and ceilings.

The small amount of headroom available aboard ship makes it necessary to provide a specially designed low horizontal compressor, driven in tandem or cross compound by a steam engine. The refrigerant, CO_2 or ammonia gas, is compressed to the required pressure and is led to the condensers, over which is circulated cold water. In the process of compression the gas becomes hot. As the water abstracts the heat the gas condenses and becomes a liquid under pressure. As soon as the refrigerant is released to a lower pressure it evaporates into a gas again, but in order to do so it takes the heat from whatever surrounds it. In this case the evaporating refrigerant expands in piping submerged in a tank of brine and cools the brine. This apparatus is called a brine cooler. It is possible to obtain a temperature of brine considerably below zero.

Steam-driven pumps force the cold brine out through the coils placed in the meat compartments. The circulating brine picks up any heat that may have leaked into the compartments and carries it back to the brine cooler. By an elaborate system of thermometers it is possible to tell at just what part of the ship the greatest heat leakage exists, if there is any.

Insulation

In order to provide against the admission of heat in the cold chambers, the compartments are insulated—that is, they are made into huge ice boxes or refrigerators. The holds of the ship where meat is to be carried are lined completely—top, bottom and sides—with a non-conductor of heat. This is packed between the skin of the ship and sheathing and is approximately one foot thick. It may be of either cork or mineral wool, a rock product made especially for this work. For one ship about seventy-five carloads of mineral wool and ten carloads of lumber are used.

The results have been most satisfactory. The usual working temperature is 15 degrees F. On one voyage of a ship built and fitted in New York harbor temperatures not exceeding 0 degree were carried by orders of General Pershing. Furthermore, the cargo was discharged at Rotterdam with the ship's hatches open, under orders that at no time during the unloading should the temperatures in the compartment rise above zero. This was successfully carried out.

Three steamers fitted in the past two years now carry 12,000,000 pounds of meat each on a single voyage; eight ships carry 7,000,000 pounds, and eight carry 5,000,000 pounds. As it is figured that an individual will consume about one-half pound of meat a day and the round trip of a meat ship takes in the neighborhood of two months, it can be estimated how many people can be fed by this fleet in a year.

For the past ten or fifteen years this country has been in the lead regarding small units for cooling ships' stores and making ice for use of the crews. For this purpose a large number of small ammonia machines has been installed in the stewards' departments on American ships and on British ships in American ports.

Motor-Driven Tanker

THE motorship *Pinthis*, a sister ship to the *Bayonne*, is a steel tanker recently built by the Tank Ship Building Corporation at Newburgh, N. Y., to Lloyd's highest class and owned by the Sugar Products Company, of New York City. The *Pinthis* will be used in the coastwise molasses-carrying trade. The principal particulars of the vessel are as follows:

Length overall	216 feet 7 inches
Length between perpendiculars	208 feet
Molded beam	35 feet 6 inches
Molded depth	17 feet 4 inches
Radius of bilge	4 feet
Designed deadweight	1,750 tons
Designed draft	15 feet 3 inches
Main engine	500 brake horsepower
Bunker oil capacity	54.2 tons
Fresh water for boiler feed—	
Fore peak	44 tons
After peak	21 tons
Double bottom	32 tons
Drinking water, daily service tanks (2)	5.2 tons
Lubricating oil storage	200 gallons
Propeller, pitch	6 feet 3 inches
Propeller, diameter	8 feet 6½ inches

The speed attained during the trial trip of the vessel, which was held on November 14, was 9½ knots. The fuel consumption of the main engine was not ascertained definitely on account of the fact that the fuel for the main engine, as well as for the donkey boiler, had to be

Fig. 1.—Stern View of Motorship *Pinthis*

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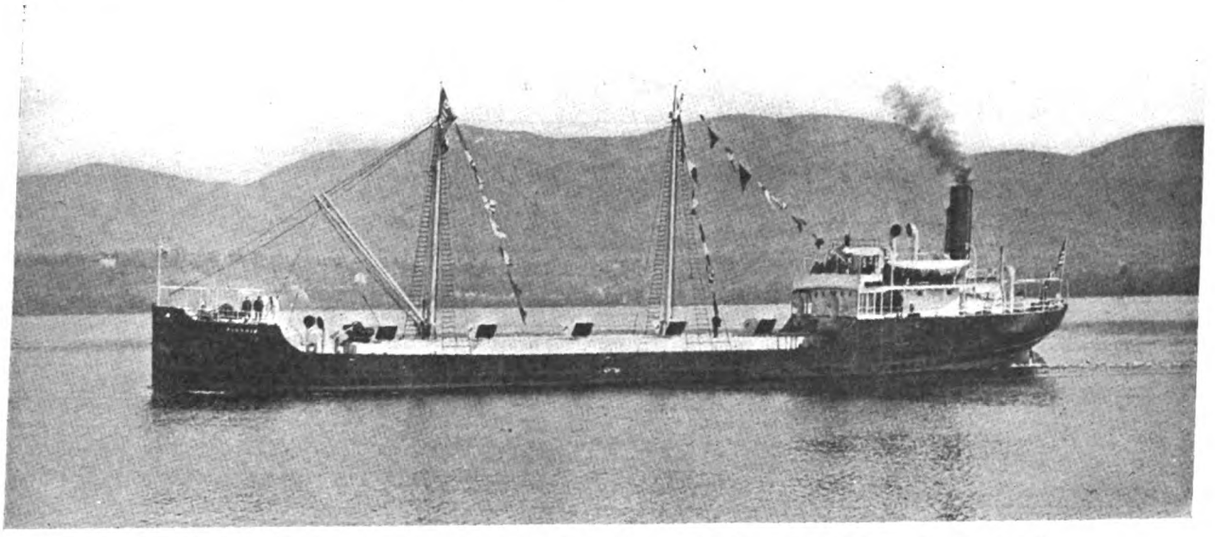

Fig. 2.—Motorship *Pinthis*, of 1,750 Tons Deadweight, for the Coastwise Molasses-Carrying Trade

taken from the same tank, but it was gaged to about .52 pound per brake horsepower per hour.

All accommodations, with the exception of the deck crew's quarters in the forecastle, as well as the engine room, are located aft. The arrangements and details are well considered and carried out in a practical and convenient way. The engine room is large and light, and an ample working space is provided around the main engine and all the auxiliaries. The main engine is a 4-cylinder, 500-brake-horsepower Bolinder engine of the surface ignition type with air injection. The engine is direct reversible and runs at a normal speed of 160 revolutions per minute.

AUXILIARIES ARE STEAM-DRIVEN

All the auxiliaries, except the reserve air compressor, are driven directly or indirectly by steam supplied at a pressure of 120 pounds per square inch from a boiler built

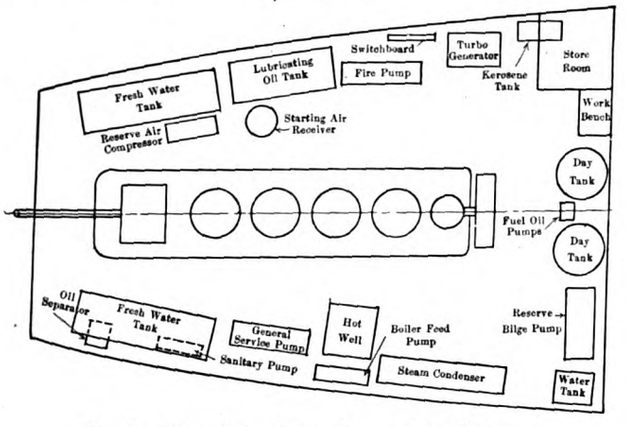

Fig. 3.—Plan of the Engine Room of the *Pinthis*

by the Vulcan Iron Works and fitted out with a "White burner" located on the upper deck forward of the engine room bulkhead.

In the engine room the service tanks are connected up to the main engine as well as to the boiler. An electric-driven rotary pump is used for pumping fuel oil from the bunker to the two service tanks. A direct-acting duplex steam pump is used as reserve bilge pump. The daily bilge pump is a standard equipment with the main engine. An electric-driven De Laval oil separator is provided which in a very short time is able to purify all waste oil collected by a pan. In this way the oil consumption is brought down to a minimum without cutting down the lubricating oil supplied to the engine.

The reserve air compressor is driven by a 3-horsepower, direct-connected gasoline (petrol) engine. This air compressor is used very exceptionally, as, for instance, after repairs to the starting air receiver. The electric plant consists of a single-stage turbine direct-connected to a 10-kilowatt, direct-current General Electric generator. The whole set is carried by two bearings only and manufactured by the Steam Motors Company, Springfield, Mass.

FUEL BUNKERS

Forward of the bridge and bulkhead is a space of four feet to the first tank bulkhead. This space is divided by the centerline bulkhead and is used for bunker fuel oil. The capacity is about 54 tons. The bunker tanks are provided with heating coils and double piping to the service tanks. An expansion trunk 3 feet high and 18 feet wide starts from the bridge and bulkhead and is carried over the bunker trunk and all the cargo tanks. These latter comprise ten tanks, five on each side. Each tank is made tight, so as to allow carrying of various liquids at the same time. Each tank is provided with a heating coil, as this tanker will be used for carrying molasses.

Forward of the cargo tanks is the pump room. All the pumps are direct-acting steam pumps and the connections from the tanks are well carried out, so as to enable the emptying of one tank into any one of the others, as well as overboard. A small cargo room is also provided for forward of the pump room.

Piston and Valve Rod Packings

There are quite a lot of various makes of piston and valve rod packings in the market. They are of two kinds, soft and metallic. Again, there are two kinds of metallic packing, the self-adjusting and the rigid types. Half way between these there is a packing in which metal is used to make a sort of rope. This is semi-flexible. Now, it is bad to find yourself shipmates with something you do not understand, so when off watch next time just write to all the makers of packing and get their catalogues and read them with care, so you will know something about all the various types of packing. Knowledge is power, and to know more than the next man may be the means of your advancement.

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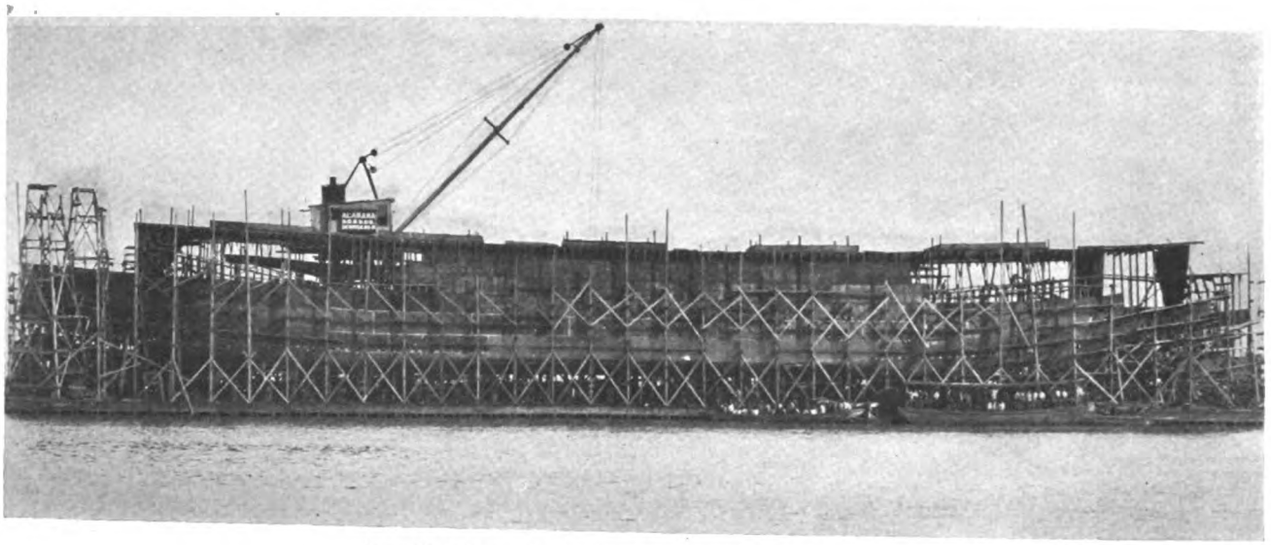

Steel Coal Barge Under Construction at Mobile Shipyard

7,500-Ton Coal Barges for the Panama Canal

Two Steel, Sea-Going Vessels Built by the Alabama Dry Dock & Shipbuilding Company, Mobile, Ala., for the Emergency Fleet Corporation

UNDER the pressure of war emergency, many shipbuilding concerns were organized in this country and their plants laid out for the single purpose of building one type of ship on which they would specialize to the exclusion of all other work. This plan of production has proved successful in getting out one type of ship rapidly, but does not tend to produce the all-around organization necessary to take care of both new construction and repairs in every department of any type ship that comes along, such as many of the old-established shipyards have, and which can continually strive to improve.

The Alabama Dry Dock & Shipbuilding Company, of Mobile, Ala., was awarded a variety of war contracts which called for an all-around plant and organization, as can be seen by the following list of work which was carried out for the various government departments:

Government Contracts

A contract to repair and put into commission the interned Austrian steamer *Lucia* and to install in this ship the Donnelly buoyancy box installation, which was one of the first experiments made by the government in an effort to develop a non-sinkable ship as a defense against the submarine. This installation was fully discussed in a paper read by Mr. Donnelly before the Society of Naval Architects and Marine Engineers in the fall of 1918.

A contract to build for the Emergency Fleet Corporation two complete Ferris-type wooden ships, the *Alta* and *Banago*.

A contract to build and operate for the Shipping Board a 10,000-ton "Donnelly type" dry dock.

A contract to build for the Navy Department three sea-going mine sweepers, the *Swan, Whippoorwill* and *Bittern*.

A contract to build for the Panama Canal two sea-going coal barges of 7,500 tons deadweight each, the *Darien* and *Mamei*. The contract for these vessels was let through the Emergency Fleet Corporation.

All of this work was carried on at the same time, along with the regular work of dry docking and ship repairs, which is the company's principal business. At the same time a small wooden schooner was built by the company for private account.

All of these contracts have now been completed, except the two barges for the Panama Canal Commission, which were not to be built as war emergency ships, but to take care of the regular business of transporting coal to the Isthmus.

Details of the Barges

In these coal barges are incorporated all the details of construction and equipment that up-to-date practice requires, and they are complete ships except for the lack of propelling machinery. The barges are designed to be towed by the Panama Canal colliers *Achilles* and *Ulysses* and are fitted with powerful towing engines and means of ready communication with the colliers by wireless telephone.

The principal dimensions are as follows:

Length overall	352	feet
Length on the waterline	335	"
Molded beam	52	"
Molded depth	33	"
Sheer, forward	8	"
Sheer, aft	5	"
Draft at full load	26	"
Deadweight tonnage at load draft	7,500	tons

Built under a guarantee to carry 7,500 long tons of coal with all stores and provisions, besides 50 tons of coal for the donkey boiler, 80 tons of feed water and 3,000 gallons of drinking water, these barges are equipped ready for sea with a draft not to exceed 26 feet, at which the block coefficient is not to exceed 0.78.

The vessels are single-deck steel barges with inner bottoms throughout and with Simpson's top side ballast tanks through the cargo holds. They are built throughout to the American Bureau classification, with poop and forecastle decks, a steel flat forward and a steel flat aft for the donkey boiler, bunkers, pumps, etc. The holds are divided by six bulkheads forming the fore peak tank, five cargo holds and the after peak tank. There is a steel

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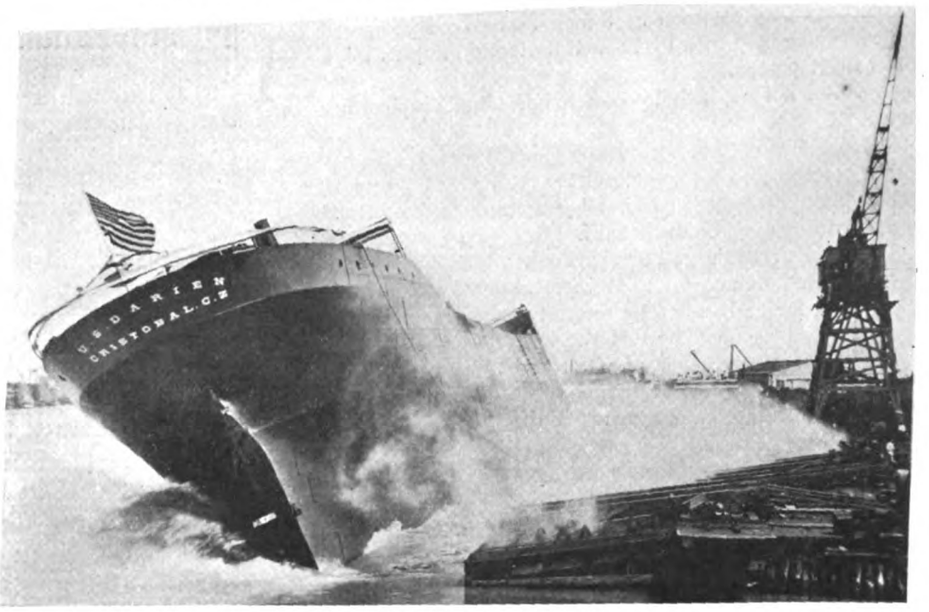
deck house on the poop deck with pilot house and bridge, captain's stateroom, wireless operator's quarters and toilets. The officers and crew are berthed in the poop deck. In the forecastle there is an anchor windlass and towing engine and the paint and lamp lockers.



Launching of Coal Barge *Darien*

RIGGING AND EQUIPMENT

These barges are schooner-rigged with four wooden masts fitted with stay sail, fore, main, mizzen and jigger sails and equipped with wireless telegraph and wireless telegraph and wireless telephone for communication with the colliers that are to tow them, the wireless antennae being carried from the top of the mizzen mast over a top mast on the jigger mast and down to a short wireless mast on the poop deck.

The auxiliary equipment consists of the following machinery:

DECK

One 10-inch by 10-inch double-cylinder No. 11 American Engineering spur-geared windlass.

One 16-inch by 16-inch double-cylinder, size "F," Philadelphia towing machine.

One 8-inch by 8-inch double-cylinder, size "F," capstan.

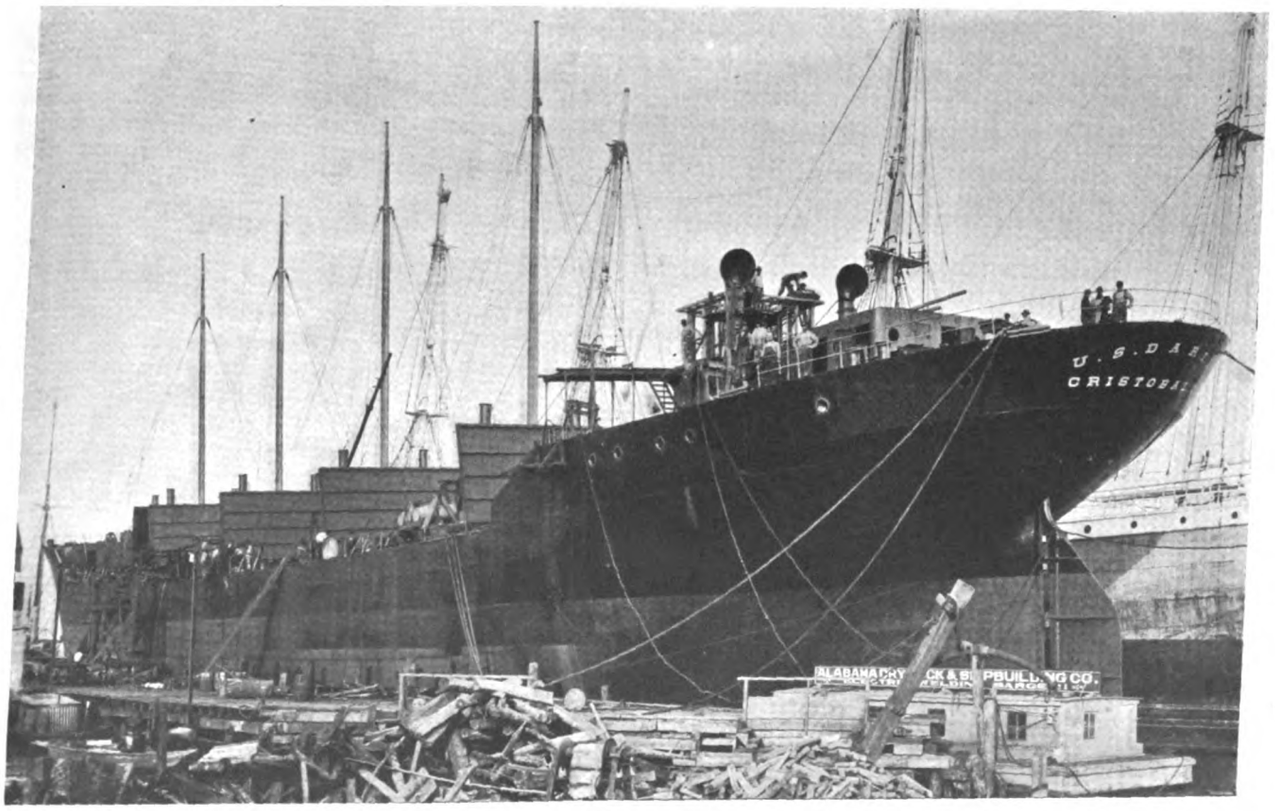
One 8-inch by 7-inch double-cylinder American Engineering Company screw-geared steering engine.

Two 7-inch by 7-inch double-cylinder deck winches.

ENGINE ROOM AUXILIARIES

One 12-foot 1⅝-inch by 11-foot 1½-inch Scotch boiler with 1,492 square feet heating surface.

One 500-square-foot surface condenser mounted over a 7½-inch by 9-inch by 9-inch by 10-inch combined air and circulating pump.



Fitting Out the Panama Coal Barge *Darien* at the Yard of the Alabama Dry Dock & Shipbuilding Company

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One 6-inch by 3½-inch by 8-inch Blake feed pump.

Two 8-inch by 7-inch by 12-inch horizontal duplex bilge and ballast pumps.

One 6-inch by 4-inch by 6-inch horizontal duplex fire pump.

One 5-kilowatt General Electric generating set.

The barges are equipped with a complete system of inner bottom ballast piping, bilge suction piping, steam and exhaust piping on deck and fire lines and steam smothering system reaching all compartments.

The main hatch covers are all steel, hinged and operated by special tackle handled by the deck winches. The tank tops and bilges up to top of the bilge brackets are covered with a 3-inch layer of pitch and two thicknesses of 2½-inch heart yellow pine planking laid first course fore and aft and top course athwartships.

The inner bottoms, insides of topside ballast tanks and fore peak tanks, chain locker, coal bunkers, floors in boiler and pump rooms and after peak tank are coated with Hermastic primer applied cold and one coat of Hermastic enamel applied hot to a thickness varying from ⅛ inch to ¼ inch, according to the location.

ACCOMMODATIONS

The quarters arranged in the poop for a crew of 18 men are finished neatly in cypress with hard oil finish and white enamel overhead. There is also provided in the poop, besides the quarters for officers and crew, regular messrooms, toilets and bathrooms, galley, ice box, store room and linen locker, dynamo room and steering engine.

From the illustrations it will be seen that these barges are first class in design, workmanship and equipment throughout. The first barge was launched on September 30, 1919, and the second on January 1, 1920, from the same ways, making about 90 days on the second hull from the laying of the keel to launching. All of the hull material was laid out and fabricated by the builders in their plate shop, as were also the boilers. In fact, the vessels are built complete at the company's plant.

The specifications were prepared by the Panama Canal Commission and follow their standard practice. The plans were drawn by Kindlund & Drake, of New York.

Shipbuilding in Australia

THE second of the Australian standard ships, the S. S. *Delungra*, is shown in Fig. 1 about to leave the Walsh Island Shipyard, Newcastle, N.S.W., for the port of Sydney, some 60 miles distant, for docking purposes prior to undergoing her sea trials to the satisfaction of the Commonwealth authorities. This is the first of the six vessels contracted for by the State shipyard, the launching of which was mentioned in the July issue of this journal.

The *Delungra* left Sydney on October 9 for her deep-sea trials, on which an average speed of 12.128 knots was obtained throughout a continuous run of 3½ hours. The trials were very complete and proved highly satisfactory. The whole of the machinery, with the exception of some auxiliaries, was built at the Walsh Island Dockyard.

Fig. 2 shows a panoramic view of the shipyard at Walsh Island, Newcastle, with the *Dinoga* ready for launching and the hull of the *Dilga* on the right nearing completion. In the background a view of the Broken Hill Proprietary Company, Ltd. iron and steel works may be seen, from which the whole of the sectional material and a quantity of the plates are obtained for the building of these steamers. A quantity of fabricated material ready for the vessels can be seen in the assembling yards at the head of the building ways in the foreground of the illustration.

The S. S. *Dinoga* was launched on October 17. The ship is in an advanced state of construction. The boilers are already installed, together with all auxiliaries. The launching weight of the *Dinoga* was 1,660 tons. Particulars of these vessels have already been published, the principal dimensions being: Length, 331 feet; breadth, molded, 47 feet 9 inches; depth, molded, 26 feet 1 inch.

The keel of the fourth vessel was laid on the slip vacated by the *Dinoga* immediately after that vessel was launched. The management are now negotiating for contracts for two or three 12,800-ton vessels, the construction of which is to follow the standard vessels.

During the month of November, 1919, two more of the Australian standard type vessels were launched. The Walsh Island yard at Newcastle, N. S. W., launched their third ship, the S. S. *Dilga*, on November 15. The keel of

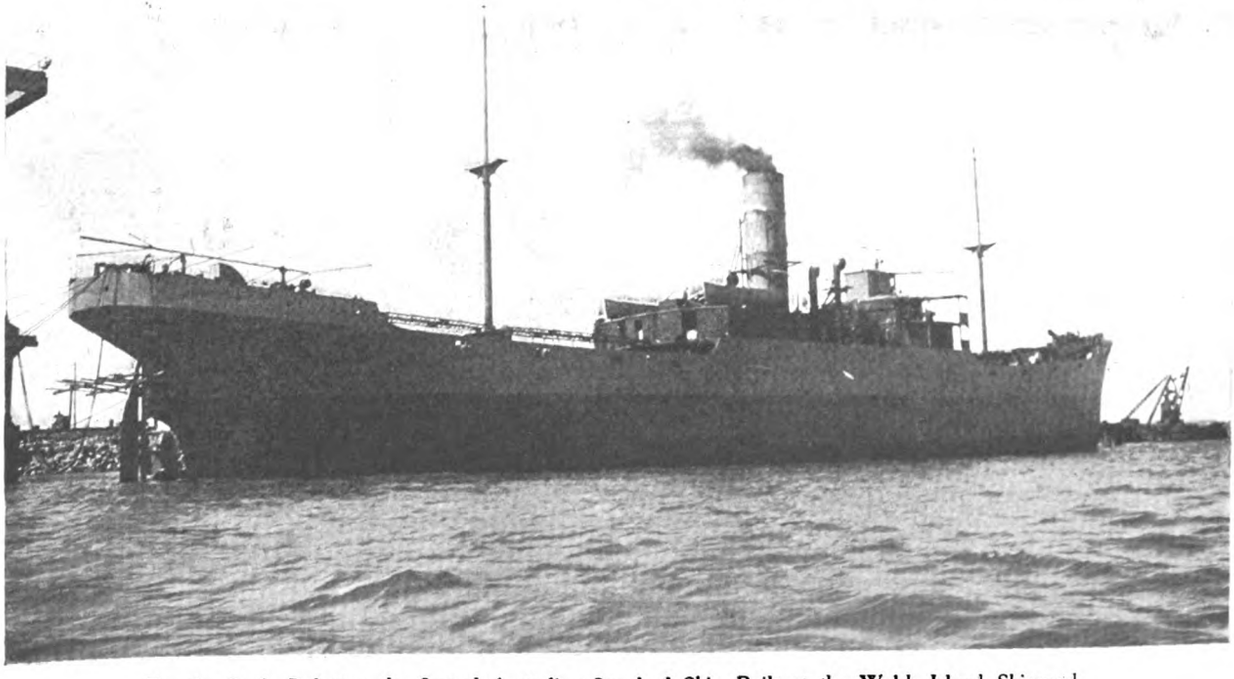

Fig. 1.—S. S. *Delungra*, the Second Australian Standard Ship Built at the Walsh Island Shipyard

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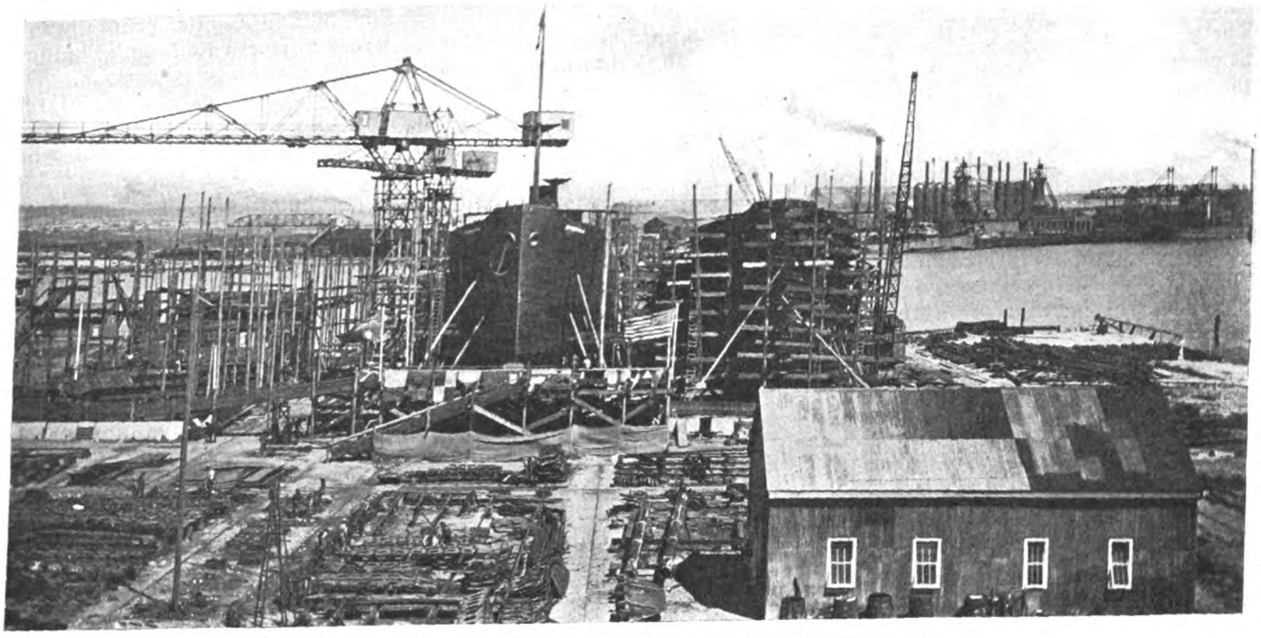

Fig. 2.—Panoramic View of the Walsh Island Shipyard at Newcastle

the sixth and last vessel of the original contract was immediately laid on the site vacated by the *Dilga*.

The *Dumosa*, the second vessel to be constructed at the Williamstown Dockyard, was launched on November 25. Her length is 341 feet; breadth, 48 feet; depth, molded, 26 feet 1 inch. Built on the Isherwood system of longitudinal framing, she is of the single-deck type, with poop, bridge and forecastle, and is classed 100 A1 at Lloyds. Her hatches are exceptionally large, and she is provided with ample cargo-handling equipment, consisting of eleven winches and eleven derricks, one of which is a 20-ton derrick.

The captain and officers are berthed amidships, the engineers being on the bridge alongside the engine casings. The crew are berthed in the poop. All accommodations are roomy, with separate mess rooms for the firemen and sailors. Baths and wash rooms are also provided.

The deadweight capacity of the vessel is 5,600 tons, on a 21-foot 9-inch draft. The machinery consists of triple-expansion engines with cylinders 25, 41 and 68 inches diameter and 45 inches stroke, and three Babcock & Wilcox watertube boilers designed for 180 pounds pressure. The engines are being constructed by Messrs. Thompson & Company, of Castlemaine, Victoria. All the sectional material was manufactured in Australia.

The first two vessels completed, the *Dromana* and *Delungra*, have both completed their maiden voyage to Ocean Island and have given every satisfaction.

Marine Terminal and Harbor Engineering

BY H. MC L. HARDING*

WHILE terminal engineering, as applied to ports, can include harbor engineering, yet as the physical work of harbor engineering has in the past been a province of the army engineers, it might be well for harbor engineering of the United States to be separated from terminal engineering. In regard to foreign port development, it will then be necessary for all the port engineering work to be combined and under the charge of the terminal engineer.

In general, terminal engineering includes the plans for the quays, piers and their substructures, water depths in slips and at pierheads, the designs for the sheds, warehouses, railway tracks and their relative locations to each other. The length and width of the piers and quays, and elevations of these above mean low water, with the dimensions of sheds and warehouses, the length and number and radii of curves of railway tracks on the piers and quays, and the length, arrangement and leads of storage railway tracks, especially pertain to terminal work.

The types of all kinds of mechanical appliances, universal and special, their installation and methods of operation, should receive the utmost attention of the terminal engineer. There should be a careful study of the movements of the inbound and outbound cargoes, and the whole design should provide for elimination of congestion points, so as to secure the utmost speed of transference and handling.

The number and lengths of berths for the discharging and loading of ships, barges, lighters and scows, the dimensions and number of quay and pier units, the open piers with facilities and equipment, as well as the shedded piers, the required capacity of sheds per unit, the drayways, dray areas and approaches come under the head of terminal engineering. There must be provision for special industries and products, manufactured and agricultural, so that all may be loaded and discharged easily and quickly, and that the inbound freight may be assorted, distributed and tiered ready for the local drays or for the cars for further carriage or for transshipment to other vessels.

The transferring capacity per unit must be known, so that by multiplying this capacity by the number of units the capacity of the whole port terminal can immediately be determined. The total cubic holding capacity of sheds and of the long-storage warehouse capacity proportional

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to the ships and the speed of flow of the freight between points must be determined relatively and with exactness. The extent and possibilities of co-ordination, especially as pertaining to the outbound freight, are not the least of the engineering decisions.

The above list might be greatly extended, but as enumerated it can serve as a basis for amplification. All permanent shore works of an operating terminal belong to terminal engineering.

Harbor engineering includes the construction and location of breakwaters, rubble mounds and harbor entrances, also the location of channels, of pier and bulkhead lines, dredging, the position of lighthouses, the collection of statistics as to water-level variations and tabulating them—in short, that work pertaining to harbors which the Federal Government has previously undertaken. With the work in and above the water, apart from the shore, the above may comprise the elements of harbor engineering.

A World's Dry Docking Record

WHAT shipping men concede to be the world's record in dry docking achievement was accomplished recently when the 30,000-ton floating dry dock of the Morse Dry Dock & Repair Company, of Brooklyn, N. Y., lifted the United States Shipping Board steamer *Minnesota*, which has a cargo capacity of 30,000 tons excluding her reserve bunker space, in only 25 minutes of actual pumping time. Not only was the *Minnesota* the largest ship that has as yet tested the strength of a floating dry dock, but the rapidity with which the lift was made is in itself a distinctive record. All sections of the six-section dock of the Morse Company were commissioned for this work.

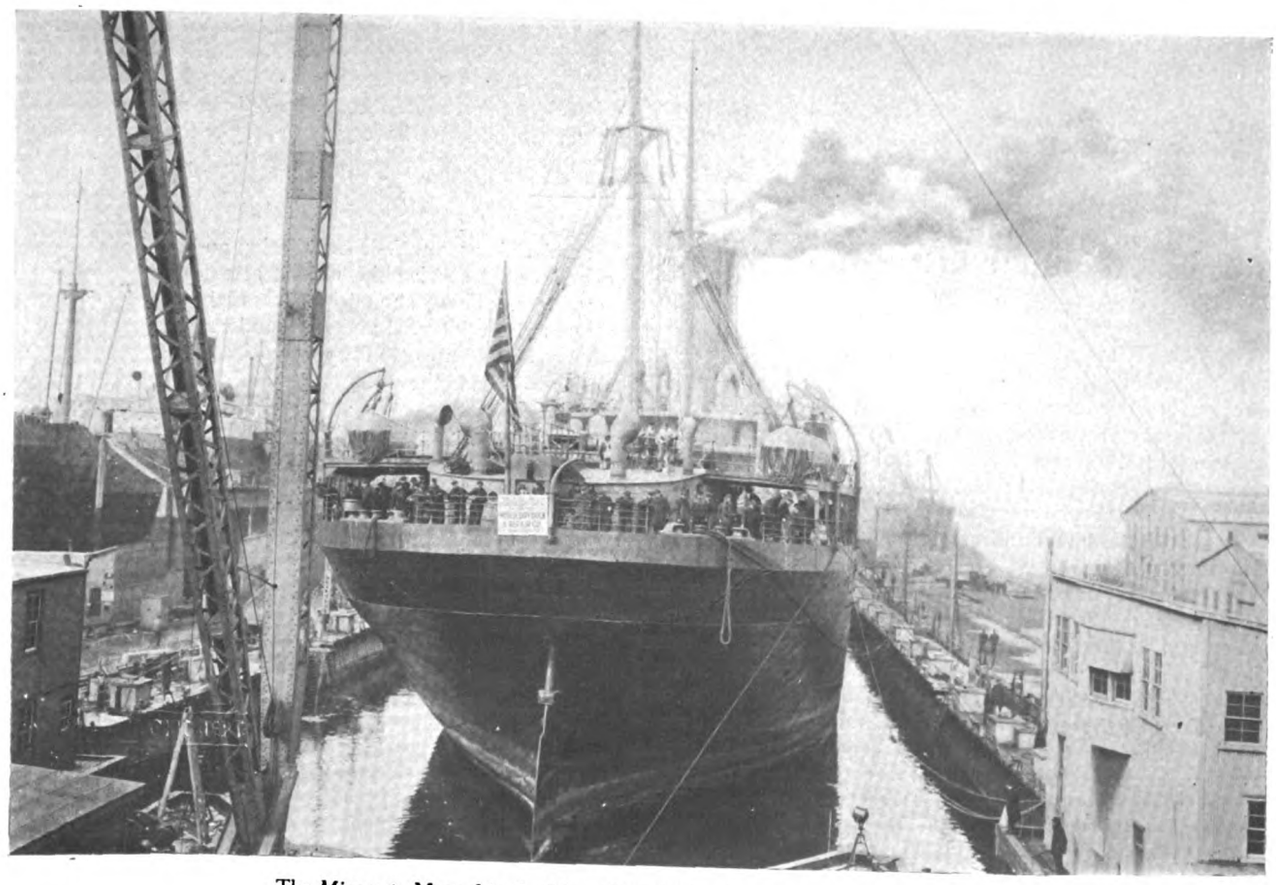
Of twin-screw type and 630 feet long, the *Minnesota* was one of two sister ships built in America primarily as a cargo carrier for the Great Northern Railway. She now has accommodations for 2,400 steerage passengers. The propelling machinery of the *Minnesota* consists of two sets of three-cylinder, vertical, triple-expansion engines of the direct acting surface condensing type, with cylinders 29 inches, 51 inches and 89 inches in diameter. Her boilers, sixteen in number, are of the Niclausse water-tube type and were built by Stirling & Company. These were constructed for a steam pressure of 250 pounds per square inch.

Centrifugal pumps, circulating 7,000 gallons of water per hour through the ship's condenser, are driven by 10-horsepower motors. The ship's docks are supported by box-shaped girders. The *Minnesota* and her sister ship were the first vessels fitted in this manner and so classed by Lloyds.

The establishment of such a notable record followed close the lifting of another Shipping Board steamer, *Eastern Cross*, in 11 minutes' actual pumping time, and the American Army transport *Powhatan* in 22 minutes. The speed attending the raising of the *Eastern Cross* is remarkable in view of the fact that only three sections of the six-section dock were used and that the *Eastern Cross* held 4,000 tons of general merchandise when she was lifted. Only four sections of the dock were required to raise the *Powhatan*, weighing 12,000 tons.

Exactly 11 minutes after the pumps started the operation of getting the *Eastern Cross* out of water, workmen were busy erecting riggings and preparing to dismantle her broken rudder parts.

This quick and most efficient "first aid" treatment administered to this ship was given in a time of urgent need, for the vessel had sustained the broken rudder



The *Minnesota* Moored in the Morse 30,000-Ton Dry Dock Ready for Docking

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when more than two days out at sea with her general merchandise cargo, bound for a European port. Her rudder rendered useless, the ship was buffeted about by winds and seas, and she made eight completed circles in a watch of as many hours. The rigging of a jury rudder was instrumental in getting her back as far as Sandy Hook after she had abandoned further attempt to reach Europe. Off Scotland light the Morse Company tugs *Dewitt C. Ivins* and *Anson M. Bangs* reached the vessel, towing her to the Brooklyn yards of the Morse Dry Dock & Repair Company.

The ship's weight, combined with her cargo, totalled close to 10,000 tons. While the new dry dock of the Morse Company is capable of lifting vessels 725 feet in length and of 30,000 tons, the raising of the *Eastern Cross* by only three sections of the dock has amply demonstrated that all six sections can give a large steamship an outside hull inspection in almost as short a space of actual pumping time.

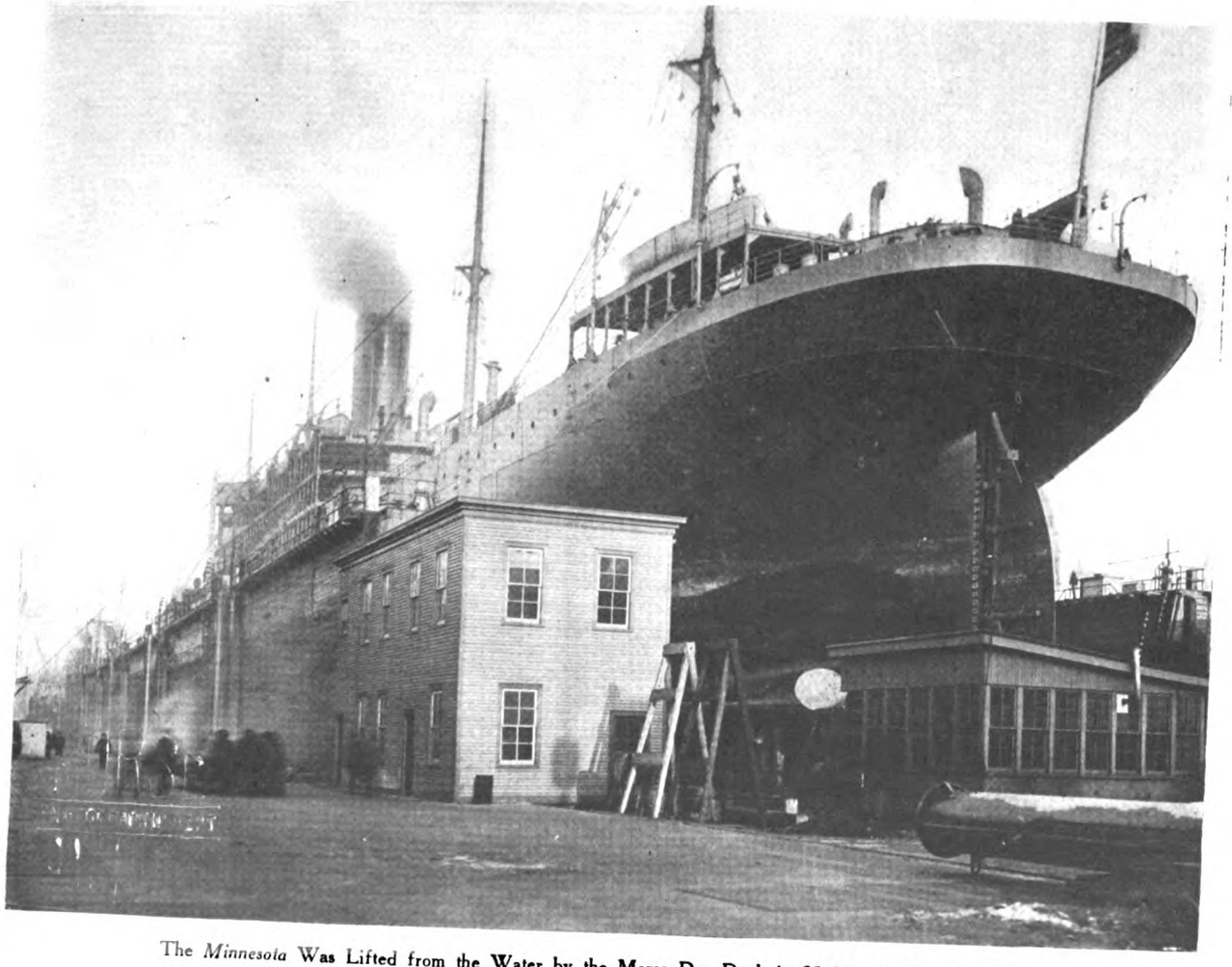
As regards expediency, this big floating dry dock of the Morse Company has given the port of New York dry docking facilities second to none in the world, and a distinctive advantage as pertains the maintenance of repair equipment to keep in commission a prosperous American merchant marine. It proves conclusively the claim of the Morse Company that large steamers can be lifted in from 20 minutes to a half hour.

When the sailing ship *Alejandrina* came to the Morse yards recently she occupied the big dry dock simultaneously with a modern steamship. But 19 feet of docking space remained unoccupied as repairers worked on the *Alejandrina* and the steamship sharing the same dock. This was a little less room than existed on another occasion when the United States Shipping Board steamer *Lake Fariston* and the S. S. *Yarmouth,* first steamship of the Black Star Line Corporation (composed entirely of American negroes), occupied the dock at the same time.

The massiveness of the dock is not altogether responsible for its sectional features. Built of six sections, two or more sections may hold a steamer while the remaining sections are submerged, ready to lift another ship. Repair work is thereby facilitated, and what was once a matter of hours and days is reduced to minutes.

FIRST ELECTRICALLY-EQUIPPED DOCK

As concerns its method of operation, the new dry dock is an exact duplicate of the older dry dock of the company, which was the first electrically-equipped dock in the world; the first on which centrifugal pumps were used for emptying it, and the first on which alternating current induction motors were used, and the first to be equipped with an auxiliary draining system. In many respects the older dry dock has been the most successful and efficient dry dock in the country, lifting in one year, it is claimed, three times the tonnage of any other dock in the same amount of time.



The *Minnesota* Was Lifted from the Water by the Morse Dry Dock in 25 Minutes' Pumping Time

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A Sixty-Year-Old Floating Dry Dock

Durability of Wooden Floating Dry Dock Proved by Long Service on Gulf Coast—Lifting Capacity, 1,000 Tons

BY PAUL H. MACNEIL

THE age, construction and checkered career of the old "Bruce" dry dock, which is still in active and successful operation at Pensacola, Fla., should be of interest to all dry dock engineers, but especially to those who believe with the writer that though this may be rightly termed the "age of steel and concrete," both of these materials have yet to prove their superiority, in many respects, for floating dry dock construction, especially on the score of time-proven durability. The

800-Ton (Deadweight) Three-Master Docked in the Old "Bruce" Dock on November 14, 1917. Note Rock Ballast and Hand Pump Handles

"Bruce" dock is but one of several old docks that have demonstrated the life of wooden construction for this purpose, but it is a worthy example.

This old pioneer floating dock was built of Florida pine at Bagdad, Fla., on the Blackwater river, in 1859-60 by Martin Bruce and William Ollinger, who had formed a partnership in 1858 to operate a small repair plant and marine railway at that port. They realized at once the advantage of a larger outfit and decided to build a floating dock. Having knowledge of a dock about the capacity that they desired, Mr. Bruce procured a set of the plans of this dock from a concern then in operation at Milwaukee, Wis. Whether or not he exactly duplicated the Milwaukee dock is not known, but it is presumed he did.

The dock was completed a short while before the outbreak of the Civil War, and upon hostilities starting the dock was sunk and the wings burned to the water to save it from possible destruction or confiscation by either the army or navy of the opposing forces. Thus it lay on the bottom of the Blackwater river for four years, when, the war being over, it was raised, repaired, the wings, or that portion which had been burned off, restored and the dock was once more put in commission. It is here worthy of note that, although the water at this port contains a sufficient amount of salt for the busy "teredo" to make a good living, the dock, when raised, had not been attacked by them during all of those four years.

The dock was successfully operated for many years at the Bagdad plant—in fact, up until about twenty-five years ago, when Ollinger and Bruce started a new plant at Mobile, Ala., where they decided to build a new and larger dock. The old dock was left at Bagdad, where, unused and its active life apparently over, it finally went to rest again on the bottom of the river.

Abandoned and supposedly forgotten, the old dock was yet destined for still better days. After a second rest, submerged, of twelve years, W. A. Watson, then connected with the Ollinger and Bruce Company at Mobile, inspected the supposed-to-be wreck of the old Bruce dock, and, finding it in remarkably good condition and having extreme faith in its durability, raised the old veteran, and, in spite of the discouraging opinions of others, repaired and again put it in commission at the old Bagdad plant.

This happened in the spring of 1917. In the fall of the same year the Bruce Dry Dock Company, of Pensacola, Fla., was organized, and upon Mr. Watson becoming interested in that project he towed his Bagdad dock to its present salt-water berth in Pensacola Bay, where it now is at home and being continuously and successfully operated by this concern.

It will thus be seen that this old dock has passed three score years of a very checkered life. Twelve years beneath the waves, part of the time in fresh water, another in brackish water, and now in real salt water. It has now taken on an entirely new lease of life and, far from being water-logged, is lifting greater loads than it ever did before; this, of course, because of the difference in density of the fresh water where it was first operated and the salt water of its present home.

The dock was built when felt and creosote protection against teredo and other marine pests was unknown. It was built by energetic but inexperienced men in dry dock work or construction. Of course, during these many years, planking and calking have been renewed, but all of the original main framing is as sound today as it ever was and is good for as many years to come. The comparatively few but essential metal parts have had to be renewed many, many times in spite of the many kinds of paints and other protection that were tried.

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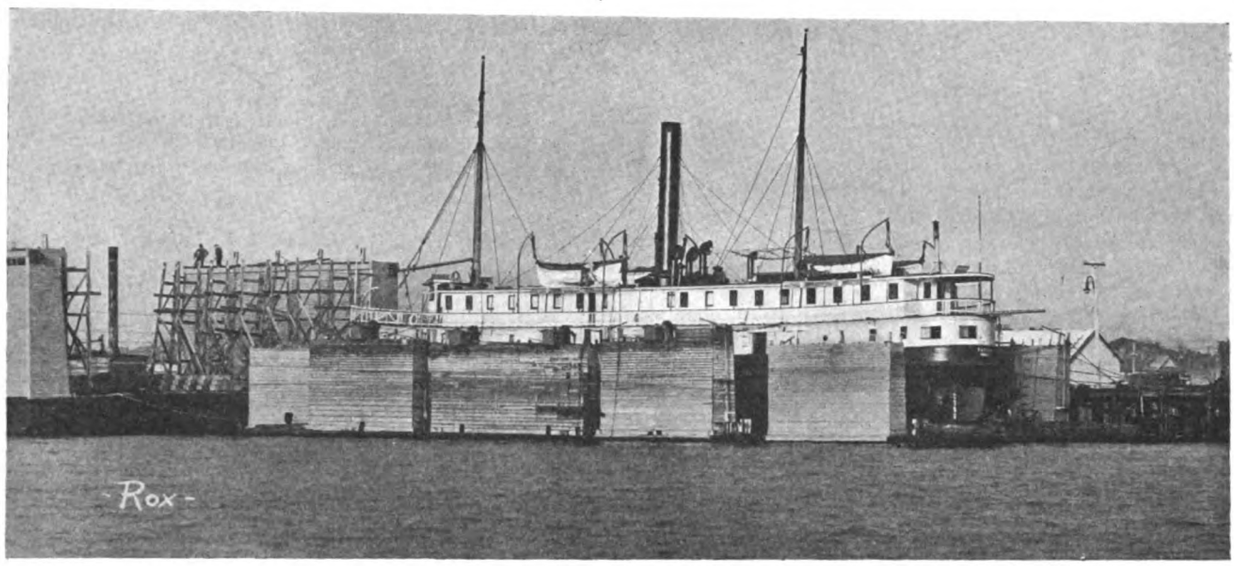
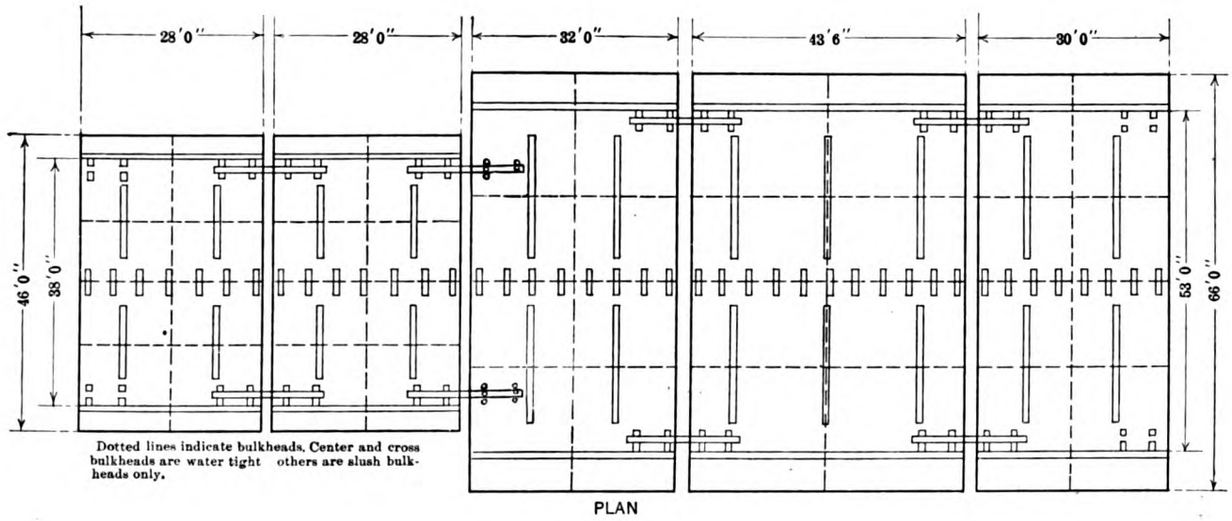
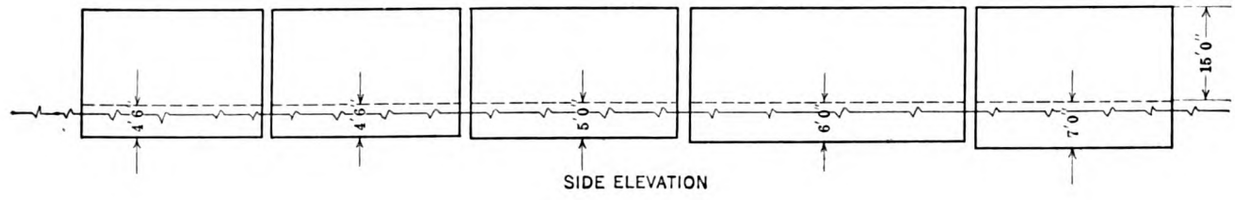


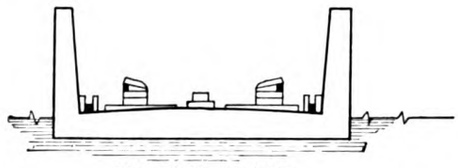
600-Ton (Deadweight) Steamer Docked in Old "Bruce" Dock on January 1, 1920. Note Electric Pump Motors and Absence of Rock Ballast; Also One Pontoon of New 5,000-Ton Dock Under Construction in the Rear



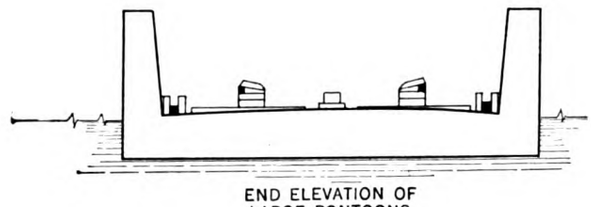
PLAN



SIDE ELEVATION



END ELEVATION OF SMALL PONTOONS



END ELEVATION OF LARGE PONTOONS

Plan, Side Elevation and Sections of Historic "Bruce" Wooden Floating Dry Dock

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The pumping equipment has now been modernized, the original hand pumps having been supplanted by steam syphons and electric pumps.

Since coming to Pensacola, felt and creosoted sheathing have been applied below the load waterline. Approximately one hundred tons of ballast, which had been previously used, was removed to add to the buoyancy of the dock, and it now has a maximum lifting capacity of a bit better than one thousand tons.

The dock is of five sections or pontoons, all interchangeable and self-docking and all of different dimensions, as will be noted on the accompanying plan. These pontoons are connected together with the old-time, familiar locking log. All calking was done with oakum.

From an operative standpoint, the dock is comparatively easy to handle, is economical in every way and with a maximum capacity load is as quickly raised as any of the modern floating docks of today. Is it to be wondered at that the present owners of this faithful old dock should be partisan to the *n*th degree towards wooden floating docks? And isn't it very logical for these people to adopt the same material throughout for the 5,000-ton dock they now have under construction to be operated alongside its older but smaller sister dock?

Absolute faith in the durability of wooden construction for this particular class of work, notwithstanding the many experts who believe otherwise, certainly seems justified by such an example as this, proven positive by the real test of time and not by theory.

A Method for Determining Diameter of Booms

BY C. A. VINCENT*

OWING to the great variations in methods of procedure and results obtained in the design of cargo and other booms, the author has endeavored, in the following article, to deduce an accurate formula that will be practical and give results compatible with general practice.

The problem will be taken up in two parts: first, to determine the thrust on the boom and, second, to determine the diameter.

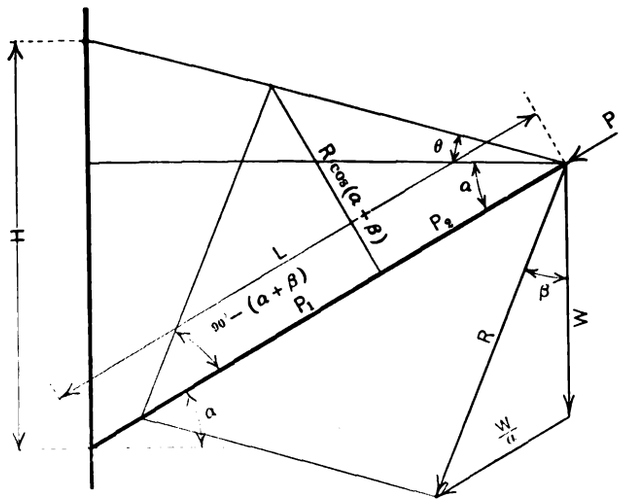

Fig. 1.—Diagram of Forces

Where

W = load.
R = resultant force.
P = axial thrust on the boom.
a = number of lines in hoisting tackle.
H = height of topping line at mast.
L = length of boom.
α = angle of inclination of boom.
β = angle of R with vertical.
θ = angle of topping line with horizontal.

Then, when the hoisting line is parallel to the boom,

$$(1)\quad P = P_1 + P_2 = R \sin(\alpha+\beta) + \frac{R\cos(\alpha+\beta)}{\tan(\alpha+\theta)},$$

and

$$\cos\beta = \frac{W(a+\sin\alpha)}{aR},\quad \sin\beta = \frac{W\cos\alpha}{aR} \text{ and}$$

$$\tan\theta = \frac{H-L\sin\alpha}{L\cos\alpha}.$$

Whence expanding equation (1) and substituting:

$$P = R\left[\frac{W\sin\alpha(a+\sin\alpha)}{aR} + \frac{W\cos^2\alpha}{aR}\right] + \frac{R\left[\frac{W\cos\alpha(a+\sin\alpha)}{aR} - \frac{W\sin\alpha\cos\alpha}{aR}\right]}{\frac{H-L\sin\alpha}{L\cos\alpha} + \tan\alpha}.$$

$$1 - \frac{(H-L\sin\alpha)\tan\alpha}{L\cos\alpha}$$

Which readily reduces to

$$(2)\quad P = \frac{W}{a}\left(1 + \frac{aL}{H}\right).$$

And in a similar manner, if the hoisting line is very near and parallel to the topping line, equation (1) still holds: but

$$\sin\beta = \frac{WL\cos\alpha}{aR\sqrt{H^2 - 2HL\sin\alpha + L^2}},$$

$$\cos\beta = \frac{W}{R} - \frac{W(H-L\sin^2\alpha)}{aR\sqrt{H^2 - 2HL\sin\alpha + L^2}}.$$

$$\tan\theta = \frac{H-L\sin\alpha}{L\cos\alpha}.$$

Then expanding and substituting in equation (1) and reducing,

$$(3)\quad P = \frac{WL}{H},$$

which shows that the value of P is independent of the angle of inclination; i. e., P is constant for all values of α.

Now, taking up the second part of the problem, to determine the diameter of a solid round boom to safely withstand the thrust P.

If an attempt is made to solve the combined formula

$$f = \frac{P}{A} \pm \frac{Mc}{I - (Pl^2 \div KE)}$$

for the diameter, an insolvable equation of the sixth degree results and a solution must be obtained from another source. Let

D = diameter of the boom at mid-length.
f = total unit allowable stress.
K = ratio = $\frac{\text{unit allowable stress for column}}{\text{unit allowable stress}}$.
w = unit weight of material.
f_b = unit stress due to bending.
f_p = unit increased stress due to thrust.
M = bending moment of a cylinder of diameter D.
JM = equivalent bending moment of boom diameter D at center.
A = area of section.
S = section modulus.
L, P and α = same as above.

* With G. M. Standifer Construction Corporation, Vancouver, Wash.

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Then

$$f = f_b + f_p,$$

$$f_b = \frac{JM}{S} = \frac{JwL^2 \cos \alpha}{D},$$

$$f_p = \frac{P}{AK} = \frac{4P}{\pi KD^2}.$$

Whence

$$f = \frac{JwL^2 \cos \alpha}{D} + \frac{4P}{\pi KD^2};$$

or

$$\pi KfD^2 - Jw\pi KL^2 D \cos \alpha - 4P = 0.$$

As K contains the element $\frac{L}{D}$, it will be necessary to substitute its value in order to solve for D. This value varies considerably with different authorities, but Johnson's straight line formula is most generally used because

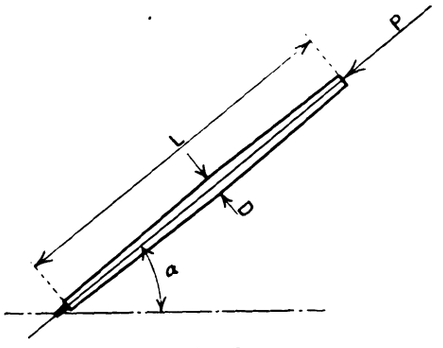

Fig. 2

of its simplicity and the fact that the results obtained agree closely with actual tests.

Then for wooden booms with round ends,

$$K = \left(1 - \frac{L}{53D}\right),$$

which gives a line tangent to Euler's curve at $\frac{L}{D} = 35$, which is near the mean ratio for booms.

When substituting,

$$\pi fD^2 - \frac{\pi LfD}{53} - Jw\pi L^2 D \cos \alpha + \frac{Jw\pi L^2 \cos \alpha}{53} - 4P = 0$$

Or

$$\frac{\pi}{4} fD^2 - (.01482 fL + \frac{\pi}{4} JwL^2 \cos \alpha) D + .01482 JwL^2 \cos \alpha - P = 0$$

and

$$D = \frac{.01482 fL + .25\pi JwL^2 \cos \alpha \pm \sqrt{(.01482 fL - .25\pi JwL^2 \cos \alpha)^2 + \pi fP}}{.5\pi f}$$

By inspection it is evident that the condition of loading causing the maximum stress in the boom is when $\alpha = 0$, i. e., $\cos \alpha = 1$; and for booms with diameter at ends equal to $0.75D$, $J = 0.9$.

Whence

$$D = \frac{.01482 fL + .70686 wL^2 \pm \sqrt{(.01482 fL - .70686 wL^2)^2 + \pi fP}}{1.5708 f}$$

Taking into consideration impact and the dry, well-painted condition of ships' booms, for Douglas fir $f = 750$ pounds per square inch and $w = 0.0197$ pounds per cubic inch. Then

$$D = \frac{11L + .014L^2 \pm \sqrt{(11L - .014L^2)^2 + 2356P}}{1178}$$

nearly, where L and D are in inches and P in pounds. For steel booms the method of deduction is analogous.

Assuming the inside diameter of the boom at mid-length as

$$0.95D, \text{ and } K = \left(1 - \frac{L}{64D}\right) \text{ and } J = 0.95.$$

Then

$$f = \frac{.40932 wL^2 \cos \alpha}{D} + \frac{P}{.07658 D^2 - .0012 LD}$$

and

$$D = \frac{.0012 fL + .03824 wL^2 \cos \alpha \pm \sqrt{(.0012 fL - .03824 wL^2 \cos \alpha)^2 + .3063 fP}}{.15315 f}$$

Taking $\cos \alpha = 1$, $f = 13{,}125$ pounds per square inch and $w = 0.283$ pound per cubic inch. Then

$$D = \frac{15.7L + .011L^2 \pm \sqrt{(15.7L - .011L^2)^2 + 4020P}}{2010},$$

nearly.

SUMMARY

When the hoisting line is parallel to the boom,

$$P = \frac{W}{a}\left(1 + \frac{aL}{H}\right)$$

And when the hoisting line is near and parallel to the topping line,

$$P = \frac{WL}{H}$$

Where P = axial thrust on the boom, W = load, a = number of lines in the hoist, L = length of boom, and H = height of topping line at mast.

For round wooden booms,

$$D = \frac{11L + .014L^2 \pm \sqrt{(11L - .014L^2)^2 + 2356P}}{1178}$$

And for hollow steel booms with an inside diameter equal to $0.95D$,

$$D = \frac{15.7L + .011L^2 \pm \sqrt{(15.7L - .011L^2)^2 + 4020P}}{2010}$$

Where D = diameter inches and L is in inches and P is in pounds.

It is very amusing to watch a man tip the long slim bottles that the oil salesman has and watch his wise expression as the bubble runs to the top. The oil man smiles to himself and clinches the order when he says, "You know something about oils, I see." Flattery is very much like oil, it smooths things in our lives.

If you had four or five old-fashioned razors, would you open them and toss them into a drawer? Of course not. Why, then, chuck your files into a drawer with a lot of junk. The files have keen cutting edges just as razors do, so just think this over and use some sense with files. They cost money these days.

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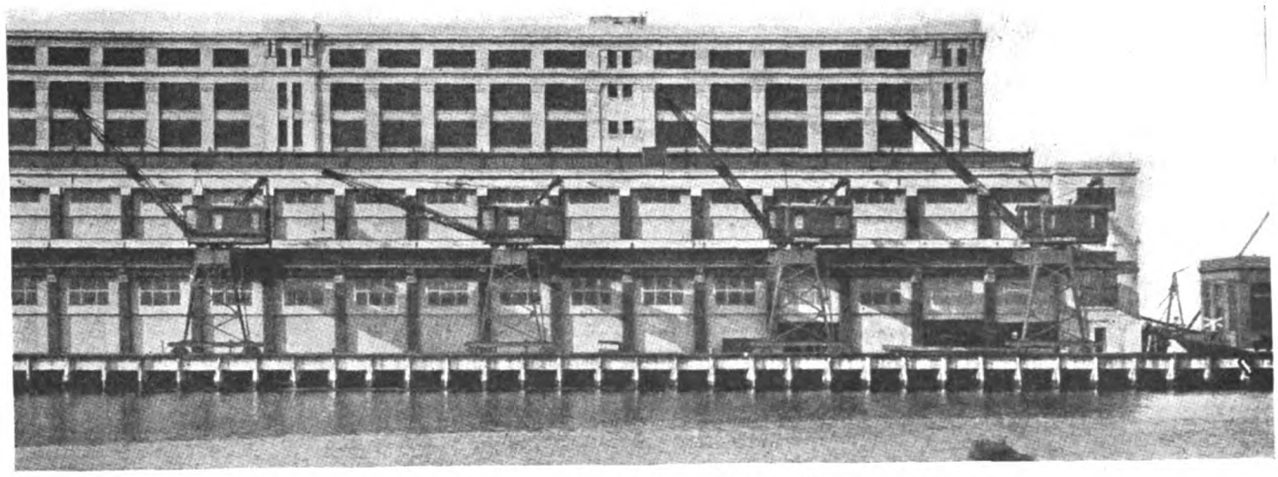

Fig 1.—Quay Terminal Equipped with Half-Arch Traveling Gantry Jib Cranes

Quay Design for Ocean, Lake, Inland River and Canal Terminals

BY H. MC L. HARDING*

It is the purpose of this paper to generalize and codify dimensions derived from a large number of quay terminals, so that it may be possible for an engineer to plan quay terminals at which there will be attained the greatest possible speed in transferring and handling freight.

IN comparison with piers, quays are more economical to construct. They allow more rapid freight movements and afford better and more rapid railway coordination.

Where the physical conditions are favorable and there is ample length of water frontage, quay construction is preferable.

Advantages of Quay Construction

Along a narrow river there is generally not sufficient water area for the piers to project into the waterway even at oblique angles, and in this case quays or slips are unavoidable. Slips dredged into the land are not advisable, if the shores are high, rocky or the land is valuable. It is a terminal principle with certain exceptions that the land area, especially in front of a city, should be conserved. This seems a self-evident truth, but the principle is often ignored.

It often happens, due to financial or other considerations, that a quay terminal should at first be installed, with provision for piers to be added later, when there is a demand for more berthing facilities.

Future Piers

Where piers are to be later installed, the quay design varies somewhat as to the shed, warehouse and railway positions. There are many locations, especially along inland rivers and narrow estuaries, where only the quay design is feasible.

It sometimes happens, however, where there are large and low waterfront land areas, that slips are excavated a considerable distance into the land with a wide land area between the two slips or a wide and long area is filled and projected into a large shallow bay. In these two cases the design is rather that of the quay than of the pier type, although the plan would seem to be of a broader pier.

Terminal Features

A terminal plan with a quay design comprises many elements, which are not merely the berthing frontages but the sheds, warehouses, railway tracks, mechanical appliances and numerous other facilities, many due to special industries, all of which pertain to securing the utmost speed in all the terminal freight movements. These elements must be so proportioned to each other that all can be operated freely without friction and at a continual speed and also having a sufficient placing or holding capacity so that there will not be the too often delay-producing congestion—that is, all open areas and cubical contents of buildings should be such that each will have but little excess over the demands that may be made upon them.

Correct Proportioning of Terminal Elements

The terminal should not be overshedded, not have too much distance between the face of the quay wall and the shed, nor too much vacant space along the waterfront.

As far as possible, the quay wall should be in a straight line divided into units. Any variations from the straight line, if necessary, should be at the end of a unit. The length of each unit should be equal to the length of the longest ship which may be expected to berth there, giving due consideration to future increases in lengths of ships.

The following lengths of units may serve as a general guide, but these dimensions, as well as others given in this paper, are subject to exceptions depending upon

* Consulting engineer, Harbor Commission, city of Milwaukee, Wis.

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local conditions and limitations. It is wise not to base one judgment or form general conclusions from a knowledge of one port, but study many ports of different countries.

LENGTHS OF QUAY UNITS

For inland rivers having a navigable depth of not more than 12 to 15 feet, where only barges will use the units, the length of each unit may be from 300 feet to 350 feet. On inland rivers of a depth of water of 25 feet to 30 feet the length of each unit may be approximately 500 feet, and along the seaboard and Great Lakes terminals the length should be from 600 feet to 700 feet. These unit lengths are for freight terminals. For passenger terminals or combined passenger and freight terminals these figures would often be varied.

As the frontage of a quay is usually straight, and as there are a number of continuous units, a ship can then readily berth even though longer than any one unit. Ships of various lengths can be accommodated along the quays without there being linear frontage unoccupied. The unit division is of advantage in financing the terminal and in providing sheds, warehouses and other facilities to the rear of each unit frontage proportioned to each other. If in pier construction the pier be 600 feet long and there be two ships each 450 feet in length, only one ship can be berthed along one side of the pier and 150 feet would be unoccupied. If one ship be on each side of the pier, then there would be 300 feet idle.

It is evident that with a straight quay, as formerly at Antwerp, there is often a continuous line of ships about six miles in length with scarcely a vacant space.

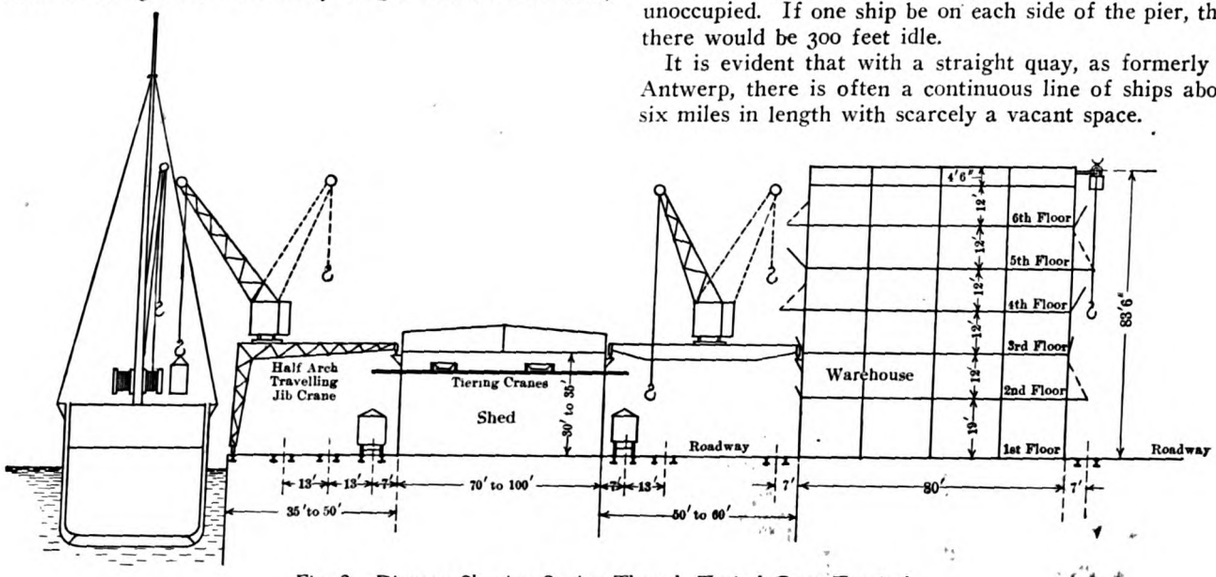

Fig. 2.—Diagram Showing Section Through Typical Quay Terminal

QUAY AREAS

For the purpose of an illustration, it is assumed that the quay unit will be 600 feet in length and that the width of this unit at right angles to the quay designed for efficient operation will be from 250 to 300 feet. There are other elements of a terminal which are common to all the units or to the whole terminal, as storage railway tracks, drayways and terminal manufacturing lofts.

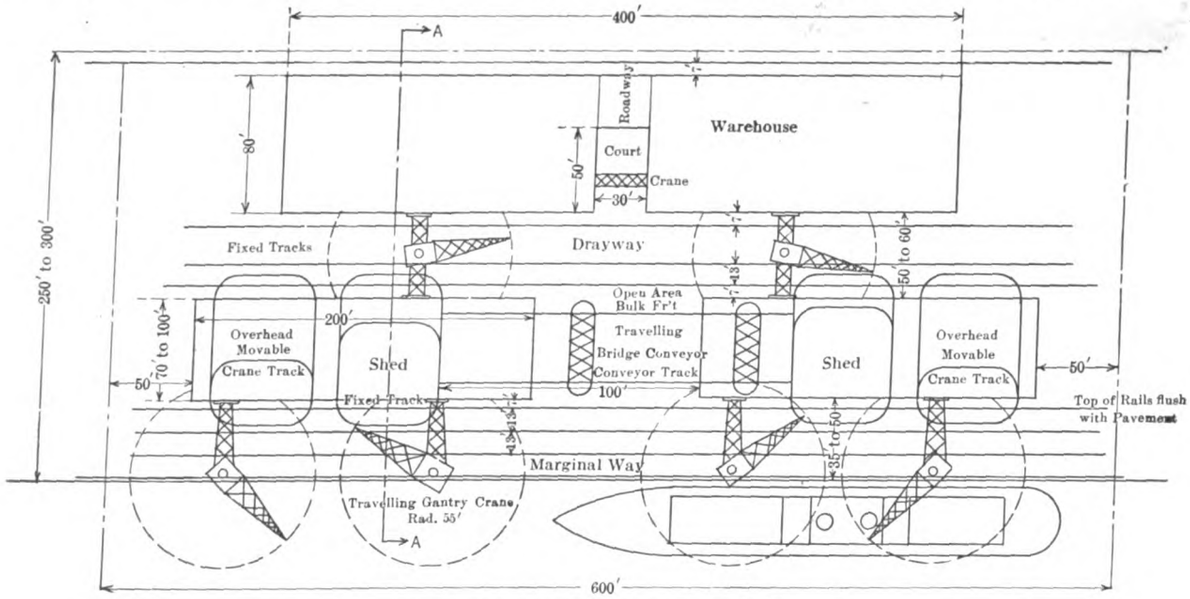

Fig. 3.—Plan of Typical Quay Terminal

DIVISION OF A UNIT LENGTH

A unit length of 600 feet should be divided as follows: Fifty feet open area at the end of this unit and fifty feet

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open area on the adjoining unit would leave here a continuous open space of 100 feet long and 250 to 300 feet wide. Next there would be a shed, preferably of one story, 200 feet in length and from 60 to 100 feet in width and 30 to 35 feet clear height beneath the roof trusses. Beyond the end of this shed there is another open intervening space between this shed and the next, of 100 feet in length, then a similar shed and then another open space of 50 feet. In adding the lengths of one unit together there will be 50 + 200 + 100 + 200 + 50 = 600 feet, the length of the unit.

QUAY SHED DIMENSIONS

In older designs the shed was from 400 feet to 500 feet or of a more continuous length, and there are advantages from this design. It was found, however, in many cargoes that there was a certain amount of inbound coarse and bulk freight that was not affected by the weather, some of which, as lumber and structural steel, was difficult to transfer into the shed and there to handle readily, that is, to distribute, assort and tier.

There was also freight for which there was no necessity

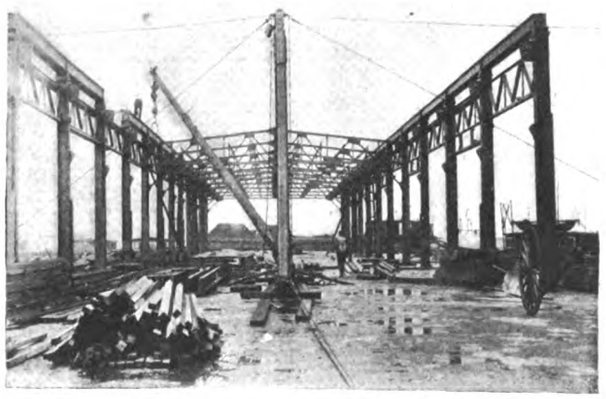

Fig. 4.—Details of Construction of Terminal Shed, Indicating One Method of Attaching Crane Rails, Steel Framing and Roof Trusses

for shed storage, and the fire risk on it was high, as, for example, asphalt in barrels.

OPEN STORAGE AREA

By having the total open storage areas 200 feet long parallel to the quay wall and 300 feet wide at right angles to the quay, with a total area of 600 square feet gross, or about 30,000 square feet net, greater speed of freight movements could be attained and at a less cost than if all commodities were placed within the shed. There is also afforded more direct access from the waterfront to the rear than where the unit shed is of one continuous length.

The width of this unit is, according to the best practice, apportioned as follows:

DIVISION OF UNIT WIDTH

The first 35 feet to 50 feet directly to the rear of the face of the quay wall is reserved for railway tracks. It is not advisable to have this distance more than 50 feet, and no freight is to be stored in this area between the edge of the quay and the shed. It is for railway tracks and drayways.

The distance between the edge of the quay and the front of the shed is generally of such length that it can be served by not more than a quarter revolution of the gantry crane jib from this edge of the shed.

There is so little difference in length between the quarter circle and the chord of this jib that the path of the crane-load is for practical purposes a straight line, without the necessity of having congestion at the place of deposition as when there is only a straight-line track.

RAILWAY TRACKS AND CO-ORDINATION

Where there is ample room there should be three tracks, the outside tracks for loading and unloading and the cen-

Fig. 5.—Southerly and Easterly Side of Quay Shed. In Front, a Small Portion of the Southerly End Is Partitioned Off for Offices

ter track for a switching track with cross-over switches at about every 100 feet.

These tracks should extend along the whole quay frontage with track connections to the rear tracks.

RAILWAY TRACK LOCATION

These front tracks, located between the shed and the quay wall, are chiefly for outbound freight, which often may be transferred from open cars or from the doors of box cars directly into the hold of the vessel.

This freight movement is chiefly from cars on the track nearest the edge of the quay, but the transference may be from any of the three tracks.

Should there not be any ship ready, the freight, if a ship is soon to be berthed there, is transferred from the tracks into the shed, and when the ship arrives from the side of the shed nearest the quay or from the overhead carriers the freight is burtoned and swung by the gantry cranes into the ship.

SHED AND WAREHOUSE FUNCTIONS

If the outbound freight is to be held for more than seventy-two hours awaiting a full cargo, it should not go

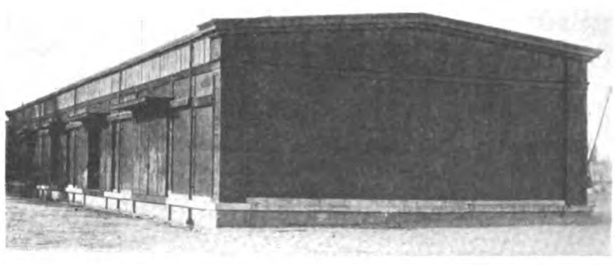

Fig. 6.—North and Shore Side of a Small Steel Shed. The Frame Is of Structural Steel with Galvanized and Painted Sides and Ends. In Front, the Floor of the Shed Is Flush with Pavement. The Foundation Is of Concrete

into the shed, but be placed in the warehouse until the ship is ready to receive it.

These frontage tracks are spaced 13 feet centers, the center of the first track being about 7 feet from the front of the shed.

Behind this front track space of the unit are the two tandem sheds, of steel construction, each being of the following dimensions:

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$(200 \times 80 \times 35) \times 2 = 1{,}140{,}000$ cubic feet.

The shed may be 100 feet in width.

The available cubical content of the largest ship there berthing, deducting space for machinery, ship stores and quarters, would not exceed from 500,000 to 600,000 cubic feet.

FREIGHT ALLOCATION

Part of this can probably be stored in the three open areas, possibly approximately 20 percent, which would leave only 420,000 cubic feet for the shed. Part of the freight may be unloaded directly upon lighters and part immediately upon the waiting railway cars and dray trailers. All freight should be moved from the shed within seventy-two hours as the maximum time of holding. Sheds are not to be regarded as storage warehouses any more than should railway cars. They are equivalent to an unloading platform. Long-storage warehouses will be provided where freight may remain as long as the storage rates are paid.

The waterfront of any terminal is necessarily of most value and is limited. The number of sheds between which and the ships there can be direct transference is therefore limited.

Many warehouses can be located to the rear of the sheds, in which freight may be held for months or years. Between these warehouses and the ships there is nothing like the number of movements that there are between the sheds and the ships. The warehouses may be placed to the rear of the sheds and some at a considerable distance if necessary. One row, however, should be located directly to the rear of the shed.

FREIGHT MOVEMENTS

In designing and planning the location of terminal works and facilities, there must be an exact knowledge of the terminal freight movements, as well as experience with the usual operating conditions. To the rear of the shed there should be a space of fifty feet between the shed and its supporting warehouse. Within this area there should be railway tracks spaced as shown on the accompanying plan. There is also a drayway and a dray area for the empty and full drays corresponding to the railway storage tracks for the railway cars.

The tops of all the rails should be flush with the pavement, so that they may be readily crossed by drays.

THE WAREHOUSE

The warehouse, 400 feet long and 80 to 100 feet wide, is in effect two warehouses joined together above the ground story, but with a court 30 feet in width separating the two wings in front. Above the first story they are connected by floors 60 feet in width. There is a passageway between the front and the rear of the warehouse through the court on the ground floor.

The lower story of the warehouse is 18 feet in height, so that railway cars can pass into and through the lower story. The upper stories are 12 feet 6 inches in height.

These warehouses are of reinforced concrete.

Behind the line of the warehouses are three more service railway tracks with the top of the rails flush with the pavement.

There may be other warehouses to the rear with storage tracks between.

THE FREIGHT SHED

Although the freight shed should be of one story, it is equivalent in height and in holding capacity to a shed of more than two stories. In fact, it may be regarded as a two-story shed with the floors and supporting girders of the second story omitted.

Such a one-story shed, equipped with overhead mechanical tiering and distributing facilities, will have at least thirty percent more workable and holding cubical space than a two-story shed with the usual fifteen feet between the floors and with supporting girders or trusses. Not only is no space lost by having the high studded one-story shed, but there is great gain in operating space. The cost of the two-story shed is more than double that of the one-story shed. The shed is for temporary holding of the cargoes not to exceed a holding of more than seventy-two hours.

Probably, on the average, including the outbound and inbound freight, seventy percent is through freight. Of this through freight forty percent may be held in the warehouse waiting for cars to transport by land to the interior of the country or for other ships to transport by water to other points. These quick movements influence the design of the shed as to size.

The function of the steel shed is not for long storage,

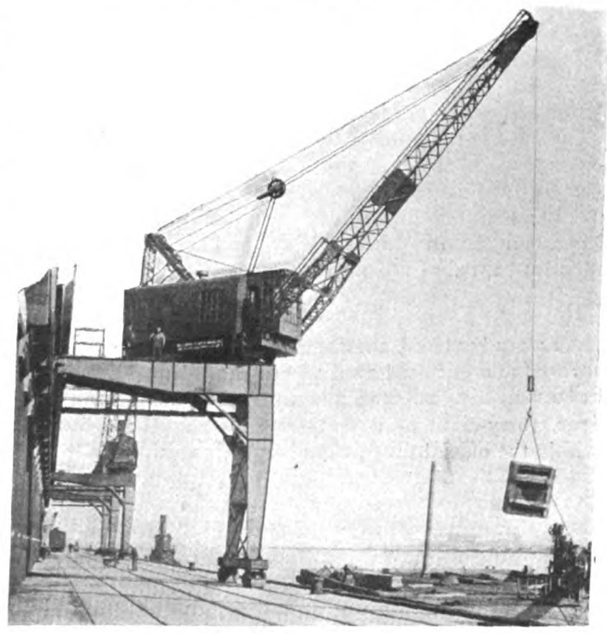

Fig. 7.—Half-Arch Traveling Gantry Crane

and this fact cannot be too strongly emphasized. Its development is closely connected with the history of quay terminals.

HISTORY OF SHED DEVELOPMENT

In the beginning there was only the open wharf without any building as a protection against inclement weather. A tarpaulin or a canvas drawn over the goods was the only protection against the rain. These goods were removed from the wharf as soon as possible. Later there was a roof of canvas and then of a more permanent material. One side was at first closed in and finally it became a building with roof, sides and doors.

Up to this time it was recognized that the shed was only a temporary location for the inbound cargoes until such time that the freight could be transferred to the store or to the private warehouse of the consignee or to land carriers or other water carriers for further transportation.

The outbound freight was sent from the factory, store or warehouse and placed upon the quay as soon as the ship was ready for its cargo. Outbound freight from the interior was generally consigned to a private storehouse or held in or on railway cars awaiting the arrival of the ship.

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After a while, as traffic increased, the shippers and consignees, with competing lines as the argument for storage favors, began using the shed as a warehouse in the same way they had been using the cars. Even though there was a high storage charge, it was cheaper than the handling and carting to remote storage buildings. The sheds being used as warehouses soon became congested and additional quay berths with sheds were continually being constructed.

Next came the warehouse, built upon the terminal area and under the control of the terminal authorities, in close proximity to the shed, so that the movement between the buildings could be performed mechanically at the least expense. This expense of moving was charged to the shipper or consignee.

These warehouses, generally of concrete, were of six stories and even more up to twelve stories, often double the length of the sheds and wider. Not only was there one warehouse behind the line of sheds, but there were many parallel rows of these towering buildings.

When the commerce of the port becomes sufficiently large, there will be warehouses for the different commodities, that is, separate warehouses for tobacco, sugar, cotton and other products.

The most important feature of the terminal is the securing of speed, that is, a rapid, continual succession of movements of the freight between the water or land carriers and the place of deposition. Any influence which produces congestion causes delay and prevents the all-important speed of freight movements from being attained.

Shed Function

As already stated, the function of the shed is to have a covered and enclosed area where the inbound freight can be assorted, distributed and tiered and held for twenty-four, forty-eight or seventy-two hours. If not removed within the official time of holding, it is mechanically transferred to the warehouse.

The outbound freight, when possible, is swung from the railway cars into the hold of the ship, or if the ship is not already berthed but soon expected the freight may be placed in the shed, if there is room. If there is a possibility of the ship being delayed or in the receiving this outbound freight, then the freight should be sent into the warehouse and from the warehouse transferred directly into the ship when the ship is ready.

Outbound freight is often held in the warehouse until a full cargo for the ship is collected. In any event, the temporary holding shed should not perform the function of the long storage warehouse.

Shed Design

The design of the shed should be such as to cause no interference with rapid freight movements. The floor space should be as free as possible from obstructions of every kind. A comparison between the operation of two sheds, one having columns and the other having a clear space without columns proved conclusively that the presence of columns was disadvantageous to the quick movements of the freight handling. As much floor area as possible should be kept for its legitimate purpose of working area and for temporary holding of inbound freight. Elevators, chutes and stairways occupy or prevent the area space from being fully utilized.

The relative locations of the quay, the railway tracks, the sheds and the warehouse are shown on the plan accompanying this paper.

Mechanical Appliances

The only possible way known to obtain a greater speed of transference and handling is by the installation of machinery. This means to adopt such standard machinery as has enabled speed to be attained at many marine terminals of foreign ports.

This does not signify a slavish copying, but the adoption of such machinery with improvement adapted to American conditions.

Traveling Gantry Jib Cranes

As the best results of loading and discharging the ships are obtained by a combination of ships' winches and gantry cranes, the correct design and the location of these cranes relative to the sheds are essential to obtaining speed.

Where the conditions will permit, the traveling half arch, gantry jib crane is preferable, as the obstruction by the rear legs is eliminated. Where half arch is not possible, the full arch should be installed.

The jib should extend fifty feet beyond the edge of the quay, and about fifty feet above the quay wall. The distance between the front and rear rails should be between 35 feet and 50 feet, and the clear height below the horizontal member of the crane from 18 feet to 24 feet, depending upon the laws of the different states.

The speed of hoisting should be from 200 feet to 300 feet per minute, the speed of revolving two or three revolutions per minute, and the speed of traveling along the quay from 200 feet to 300 feet per minute.

There should be a separate motor for each of the three movements of hoisting, revolving and traveling. In general, these miscellaneous cargo cranes only have the three movements. Should the cranes have the derricking movement in addition, there should be a fourth motor for this movement.

Crane Capacity

The type of gantry jib crane best adapted to the discharging and loading of miscellaneous cargoes may be designed as the 2- to 4-ton crane.

Such a crane with one rope has a lifting capacity of two tons with a hoisting speed of 200 feet to 300 feet per minute and the same crane has a capacity of four tons at one-half the above hoisting speed. This 4-ton capacity is provided so that the clamshell or grab buckets may be operated when desired.

The above cranes have a temporary excess capacity of fifty percent.

At a public terminal it is known in advance that freight of every kind and description will be transferred and handled and any machinery must be universal in its character.

These cranes should be of a rugged type, or low first cost, so that it may be possible to install a sufficient number to secure the utmost speed in loading and discharging. At Hamburg there is a crane for every 62½ feet.

Number of Cranes

To obtain the best results there should be two cranes operating at each hatch of the ship. There should be one slow-speed stationary jib crane of a capacity of about 25 tons, located where it will not interfere with the travel of the gantry cranes. Provision should be made for the attachment of an electric motor in the future.

Shear legs would sometimes be of great service to the port and may be installed.

Operation

In loading, the gantry jib crane swings the load by an almost straight line and lowers into the ship hold.

In discharging, where there are winches on the ship, these winches can draw from between decks to above the upper deck and the draft is then burtoned to the hook of

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the gantry crane, which swings to the place of deposition. By this combination of the ships' winches and the gantry cranes the best speed known is obtained. Instances have occurred where four to six drafts are moving simultaneously at one hatch and at five hatchways there may be from twenty to thirty drafts.

To assort, distribute and tier this great volume of freight properly there is required some kind of overhead machinery to relieve the floor of possible congestion. A modification of the overhead traveling crane, but with a lateral travel of a number of grabs, instead of only one travel between the sides, well fulfills the exacting conditions of these freight movements and serves every square foot of the floor area and every cubic foot of space.

There should be as many direct paths as are necessary, whereby the freight can be lifted from the floor of the shed and delivered to the gantry cranes for lowering into the hold of the vessel. The mechanical lifting is of equal importance with the mechanical conveying. It should also be commercially practicable to serve equally well by the same machinery cars in the rear of the shed as well as those in front. The plans accompanying this paper explain the general arrangement of the terminal.

That there may be no delay in the moving of the freight held in the shed beyond the specified time, between the shed and the warehouse, cranes as shown in the design are provided. There is not the same necessity for machinery within the warehouses as in the sheds, as freight, especially in the upper stories of the warehouses, may not be moved for months. There should, however, be provided machinery for quick elevating and lowering, chiefly large elevators within the building and whips outside.

CONCLUSIONS

First.—That the most important feature in quay terminal design is the securing the utmost speed in all cargo and freight movements.

Second.—In order that this result may be attained, all the terminal elements should be relatively proportioned to each other so as to eliminate the possibility of congestion points.

Third.—That the only way to improve existing conditions is to utilize standard mechanical appliances which are in successful commercial operation.

Diesel Engine Construction in Europe

BY OUR SPECIAL LONDON CORRESPONDENT

Although in the early stages of Diesel engine development British shipbuilders and marine engineers adopted a very conservative attitude towards the motorships, they are now apparently all so thoroughly convinced there is a great future for the internal combustion-engined vessel that large sums of money are being expended in equipping their works for oil motor construction and experimental work. It is the current belief in Great Britain that the day of the motor passenger liner of 20,000 to 24,000 horsepower is not far distant.

AS an instance of the thoroughness with which some firms have gone into the question, it may be mentioned that Doxfords, whose output of merchant ships last year was equal to that of any English shipbuilders, have spent $487,000 (£100,000) in new equipment and experiments, although they have not yet built a single motorship. Yet they are far-sighted enough to believe that this is the best investment they have made, for they have developed an oil engine with which they are so thoroughly satisfied that they are standardizing it for cargo ship propulsion and are now building two sets of the standard type (3,000-horsepower, 4-cylinder engines) to be installed in vessels of 10,600 tons deadweight capacity, which they will probably operate themselves.

LARGE PASSENGER MOTORSHIPS COMING

Similarly, Harland and Wolff have equipped magnificent shops at Glasgow solely to build oil engines up to 6,000 horsepower. Armstrongs, Vickers and Beardmores have done the same on a slightly smaller scale, while the North British Diesel Engine Works at Glasgow has been laid out at a huge cost, with a plant designed to build marine Diesel motors up to 12,000 horsepower. For it is the current belief in Great Britain that the day of the motor passenger liner with engines of 20,000 to 24,000 horsepower is not far distant. Indeed, plans have already been prepared for such vessels, and as Lord Pirrie is connected with the project it is not likely to die of inanition.

The Johnson Line of Stockholm has just added another motorship to the nine which it already possesses; and as it is now building oil-engined vessels to the exclusion of steamers, this gives a good indication of the relative value of the two classes of craft—at any rate for the trade upon which the Johnson Line is engaged.

The new vessel, which is due to start immediately on her maiden voyage from Stockholm to America, is the *Buenos Aires* and may almost be termed a stock boat, so many exactly similar craft having been built. She carries 9,400 tons deadweight and is equipped with two 1,550 indicated horsepower, 4-cycle Diesel engines constructed under license from Burmeister and Wain by the Gothenburg Shipbuilding Company, of Gothenburg, Sweden, where the *Buenos Aires* was built.

EARLY BURMEISTER AND WAIN DESIGN STILL FOLLOWED

It is a remarkable fact that these engines, excepting in minor details, differ only slightly from the first Burmeister and Wain sets which were installed in the pioneer motorship *Selandia* in 1911. The chief difference lies in the air compressor arrangements for the injection air, since in the latest type a self-contained vertical three-stage compressor is fitted on each engine, whereas in the early machines only the high-pressure stage was operated from the main engine and the low- and the intermediate-pressure cylinders were entirely separate, driven either by an electric motor or by a high-speed Diesel engine.

Another modification in design, which is to be noticed in the latest Scandinavian motorships, is instanced in the *Afrika*, the world's largest motor vessel which is now nearly completed for the East Asiatic Company. This

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concerns the engine room auxiliaries more than the propelling plant. All deck winches (of which there are 20), the anchor windlass, steering gear, refrigerating plant and pumps are electrically driven (this is the modern European practice), and the power is supplied from no fewer than four Diesel-driven, 220-volt generators in the engine room. Hitherto two, or at most three, sets were installed, but there are various advantages in providing four of relatively small power. In the first place they are identical in every respect, so that the number of spare parts required is reduced, while it allows of great convenience in operation. At sea, two sets are easily sufficient for the work, while in port, when all the winches are working, three generating plants will take the load, still allowing one as standby. Again, when in port, with the ship lying idle, when electricity is only required for lighting and one or two odd pumps, a single set will do all that is needed. Each of these generating sets is of 60 kilowatts driven by a two-cylinder, high-speed Diesel engine, a neat self-contained plant, which, by being thus standardized, can be, and is being, turned out in dozens by the manufacturers at relatively low cost.

FOUR-CYCLE VS. TWO-CYCLE ENGINES

Much controversy has been aroused recently in Great Britain over the question of the most suitable type of Diesel engine for marine work, and it is proof of the lack of unanimity which exists to mention that of the six leading builders in the country—Vickers, Harland and Wolff, North British Diesel Engine Works, Armstrongs, Doxford and Cammell Lairds—the three former have wholly pinned their faith in the four-cycle motors, while the three latter are relying with equal determination on the two-cycle, single-acting type. One thing appears quite certain: that the valve-scavenging, two-cycle motor, such as was built at the Navy Yard at New York some years ago for installation in the *Maumee*, is quite dead so far as British engineers are concerned. The danger of cylinder cracks is considered to be too great for practical utility at sea, and the ill-success of the Krupp-engined, American-owned *Glenpool* (ex-*Hagen*) certainly gives some ground for this belief. It is understood that the 3,900-horsepower engine being built by the Bethlehem Shipbuilding Corporation is to have valve scavenging, but it is possible that this is incorrect.

It is curious that the opposed piston, two-cycle engine has not been taken up in America, for both Doxfords and Cammell Lairds are building to this design; but there is reason to believe that a well-known American firm will shortly construct the Cammell Laird engine under license. In England a good deal of faith is placed in the opposed piston type, as it is very suitable for low propeller speeds, and the 3,000-horsepower Doxford engines mentioned above have a maximum speed of 77 revolutions per minute, which is just what is required for the average 10,000- to 14,000-ton cargo ship.

Welding an Engine Cylinder from the Inside

Twenty-Five Patches Welded on Interior of Cylinder By Electricity Without Distorting Bore of Cylinder—Notable Example of Cast Iron Welding

BY OTIS ALLEN KENYON

IT is believed by many that welding on the inside of an engine cylinder on the working surface is an operation fraught with danger to the engine. First there is the difficulty of welding cast iron and then there is the danger of distorting the bore of the cylinder by the heat. In fact, the job here described was turned down by several professional welders before it was finally brought to the Electric Welding Company of America, Brooklyn, N. Y., which did the job.

This company, which has been in the welding business for over ten years, makes a specialty of cast iron work, and the mere fact that it has done this class of work on a commercial basis for many years goes to prove a contention that is often made by the writer, namely, that it is the welder and not the machine that determines the success of cast iron welding.

In cast iron welding there are three things that must be guarded against, if success is to be had, namely:

1. Layer of hard and brittle metal at the fusion line.
2. Strains due to shrinkage of the deposited metal.
3. Strains and distortion due to temperature stresses in the casting.

It is easy to point out that these things are to be guarded against, but it is quite another to be able actually to do it. There are many cast iron jobs that are easy; others are difficult, and still others are impossible with our present limited knowledge. It requires an expert to know in what class any given job comes, and, knowing this, he must plan the method of doing the work so as to minimize or eliminate the troubles listed above. This knowledge cannot be expected in a welding operator. A man who knows that much earns more money. On the other hand, nobody but a trained operator can carry out the instructions given by a man expert in cast iron work.

To go back to the three difficulties, the first one is the hardest to overcome in all but a few instances, because it is due to absorption of carbon from the cast iron by the newly deposited metal. Molten iron has a great affinity for carbon and the cast iron has a lot to spare, so that when the two come together the metal from the welding electrode takes up the carbon and forms a layer of very high carbon steel. To make matters worse, this newly formed steel is quickly chilled by the mass of relatively cold cast iron on which it has been deposited. This combination of very high carbon and extremely rapid chilling makes about the hardest steel that can be imagined.

The only remedy for this effect is to remove the carbon from the surface of the cast iron, but this is easier said than done. In many cases it simply cannot be done by any method known to the writer. There are two methods of removing the carbon and several methods of reducing its ill effects.

The removal of excess carbon from a cast iron surface preliminary to welding requires great skill on the part of the operator. The ordinary soft steel electrode after having passed through the arc is practically carbonless, so that upon coming into contact with the casting it draws carbon. Now, if the welder plays his arc on this freshly

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deposited metal, directing it always to the hottest point, he will flow off this high-carbon steel that has just formed and the surface will have just that much less carbon in it. This operation can be kept up until the welder thinks he has removed sufficient carbon to permit the making of a good weld.

It will be readily appreciated that this process cannot be carried out in every case. The casting must have sufficient heat-dissipating capacity and the weld must be so located as to permit the overheated metal to flow clear of the work.

Another way of reducing the action of the carbon is to use a carbon-absorbing flux for flowing the flux out of the weld. In cases where these expedients are not possible, precautions must be taken to prevent the carbon trouble from spoiling the job.

Heating and slow cooling greatly help by reducing the brittleness. Studding the joint prevents failure due to brittleness at the fusion line.

Strains due to shrinkage can be avoided by proper design of the joint supplemented by proper welding technic. Such strains must always occur where the same welding string is fused to cold metal on two opposite sides. The only way to fuse onto opposite sides and not experience trouble is to heat the metal surrounding the weld to permit the distribution of the strain. In some cases there is no other way out.

Strains and distortion due to heat from the welding are often claimed by makers of arc welding equipment not to exist. It is true that compared with oxy-acetylene welding the heat disturbances of the arc are almost negligible, but this is a property of all arcs and not specially enjoyed by any particular type of machine or system.

When there is a lot of metal to be deposited in a small area, preheating must be resorted to. It stands to reason that if an arc is held practically in the same location for hours, as is sometimes the case, unequal heating is bound to take place. Preheating for arc welding is by no means the serious objection that it is for oxy-acetylene welding. In the case of arc welding it simply means plying an ordinary blow-torch on the work until it is warm. It need never be hotter than can be touched with the hand.

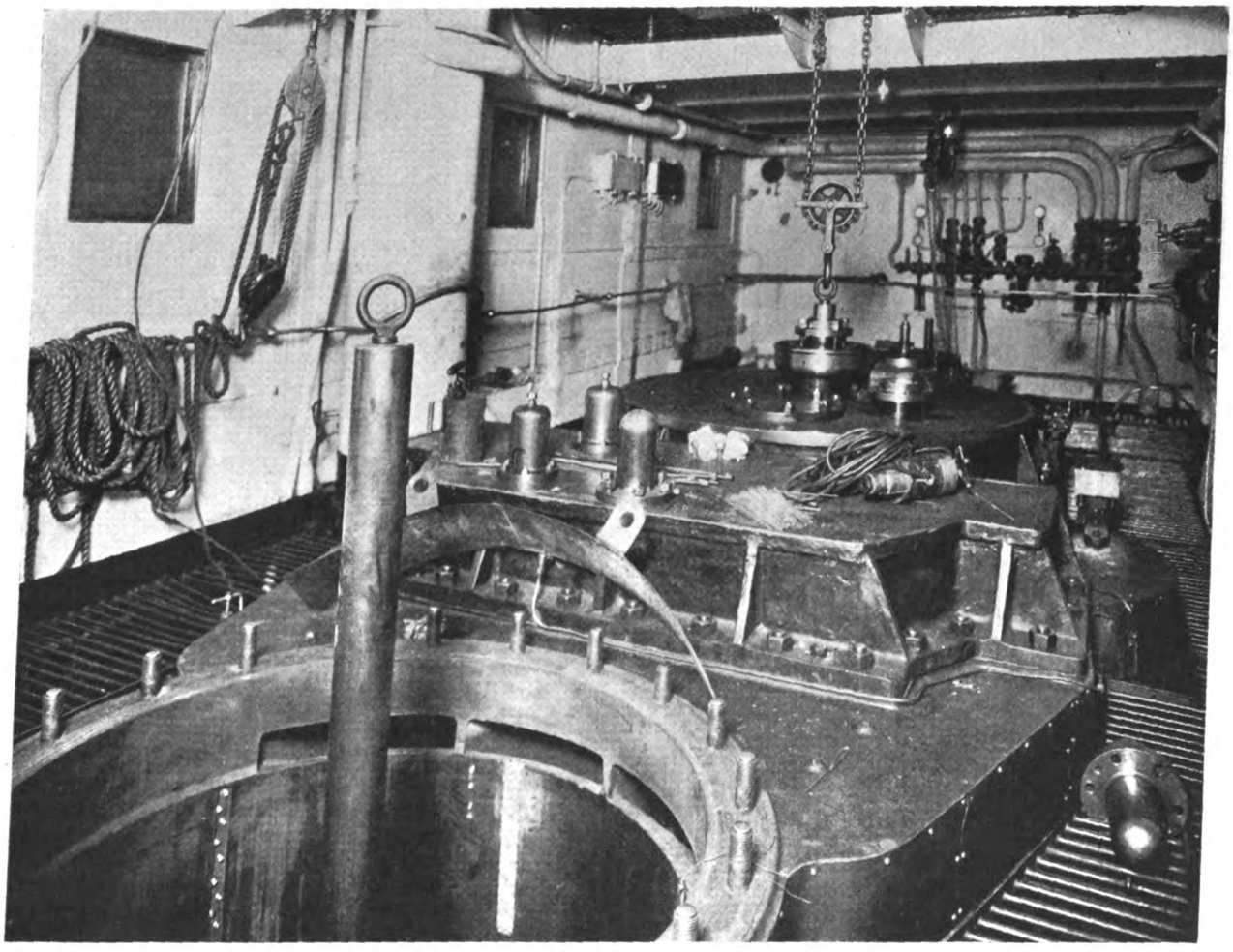

Fig. 1.—Engine Room of Brazilian Steamer *Uberaba*, Where Deep Scores and Breaks in Intermediate Cylinder of Quadruple Expansion Engine Were Successfully Repaired by Electric Welding

Before we get more involved in the technic of cast iron welding, perhaps it would be well to return to the subject in hand. The engine here in question is a quadruple expansion marine type, which develops 4,500 horsepower at a steam pressure of 220 pounds per square inch and normal speed. It forms part of the equipment of the Brazilian steamer *Uberaba*.

The damage consisted of a number of deep scores and breaks in the intermediate cylinder, which is 56 inches in diameter and has a stroke of 50 inches.

Preparatory to welding, the faults were all opened up with a pneumatic chipping hammer so as to expose the

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full extent of the damage and to provide sufficient space to assure the possibility of applying proper welding technic in the depositing of the metal. This prepared space was next drilled with a portable drill and the holes tapped to receive studs, as shown in Figs. 2 and 3.

The joint in the vicinity of the work was slightly warmed with a small blow-torch before welding. The torch may be seen in Fig. 1, where it is shown at the left and on top of the low-pressure cylinder.

The electricity and the compressed air were obtained

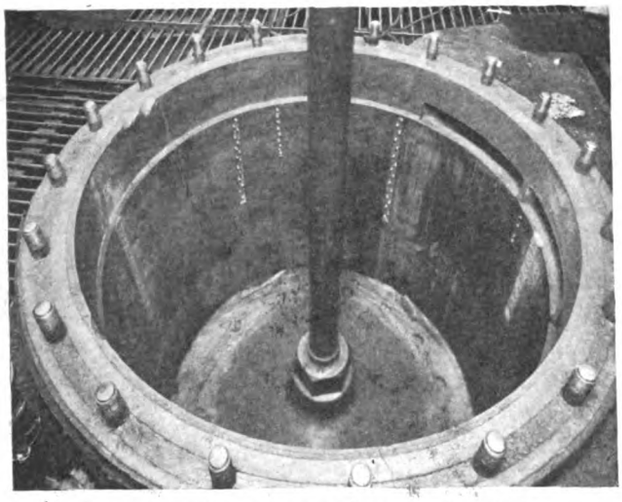

Fig. 2.—Looking Down Into Damaged Cylinder

from the welding company's floating plant, which was brought up alongside the ship.

The welding itself was done with a special coated electrode made in the laboratories of the Electric Welding

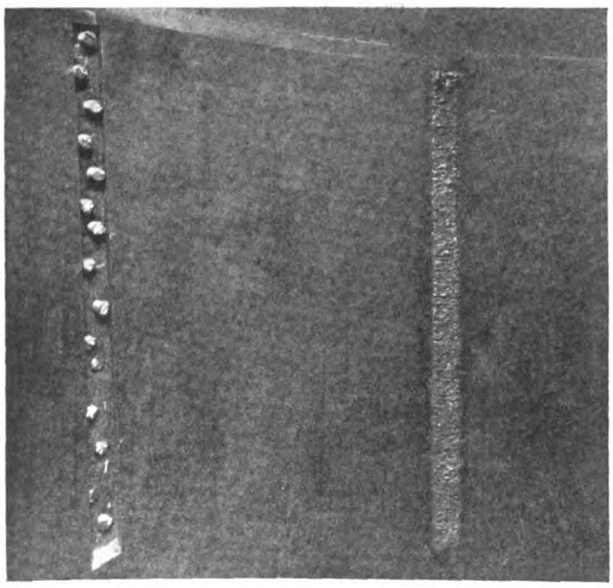

Fig. 3.—"Close-Up" View of the Welds

Company of America. After the welding patch was completed, as shown in Fig. 3, it was ground to true contour by means of a portable grinder and a special gage. While using the arc the valve ports were protected from injury by a sheet metal screen that was hung over two of the cylinder studs.

The illustrations show some of the stages of the work with remarkable clearness. Fig. 1 is a general view of the engine looking along the tops of the cylinders and toward the low-pressure end. The electric cables from the floating plant may be seen hanging down from the deck above. Fig. 1 also shows the blow torch and the portable drill, as well as the screen that was used to protect the valve ports. Fig. 2 looks right down into the cylinder and shows the location of the damaged portions. A number of the faults have been prepared for welding, and one at either side of the picture has been filled with welding material.

Fig. 3 is a "close-up" of the work. It shows how the cylinder is prepared to receive the welding material and also how the welding material looks in place and before it is ground. Once it is ground it becomes invisible except upon very careful examination. There were twenty-five patches put in this cylinder.

Proposed Method of Placing Screens on Port and Starboard Lights

BY E. DE BRUIJN

THE port and starboard lights for steamers, sailing vessels and any other kind of water craft traveling at night play a very important part in navigation, and consequently the screening of these lights is a matter that should receive careful consideration. As we all know, the rules and regulations of navigation prescribe the angle at which the port or starboard light may be seen shall not be less or greater than two points of the compass abaft the beam, and that the light shall be visible directly in front, or, in other words, the rays should be thrown parallel with the centerline of the ship. The angle of visibility is thus 112½ degrees. But we will find that this is not the case if we regard the accompanying sketches of the present way of screening. Compare this with the proposed way and the principle will be evident at once.

Before studying the sketches shown in Figs. 1 and 2, attention should be directed to the law of nature, that if a ray of light passes through space or through a vacuum this ray is not visible, but as soon as same is obstructed in its course by any object it will either go through it or fall upon it, and in both cases this body or particle will be lit up and thus give light.

If we apply this rule of nature to the port and starboard lights we will have three points to consider: (1) The source of light; (2) the rays produced by the source; (3) the lens, or the object through which the rays are thrown.

In Figs. 1 and 2 the source of light is a mazda lamp, which is, of course, of minor importance, as, for that matter, any light will do. Both lenses in Figs. 1 and 2 have the same radius, and also the reflectors are of similar make and design. The only difference in the construction is the placing and length of the screens.

In Fig. 1 the screen *A* and *B* may be of any length, say from one inch up to two or three feet, whatever the condition on board the ship may be, but in Fig. 2 the length of these screens must comply with certain rules, which will be explained later.

The present way of screening is based upon the visibility of the direct rays, produced by the *source* of light, but the indirect rays are also important factors which must not be overlooked.

At present the angle is taken from the center of the *source* of light, which, the writer believes, is in error, because the object that really gives the light is the lens, so that we ought to take the angle produced by the two tangents to the outer side of the lens.

My proposal is to place the screens so that the outer edge of screens *D* will touch the tangent which passes

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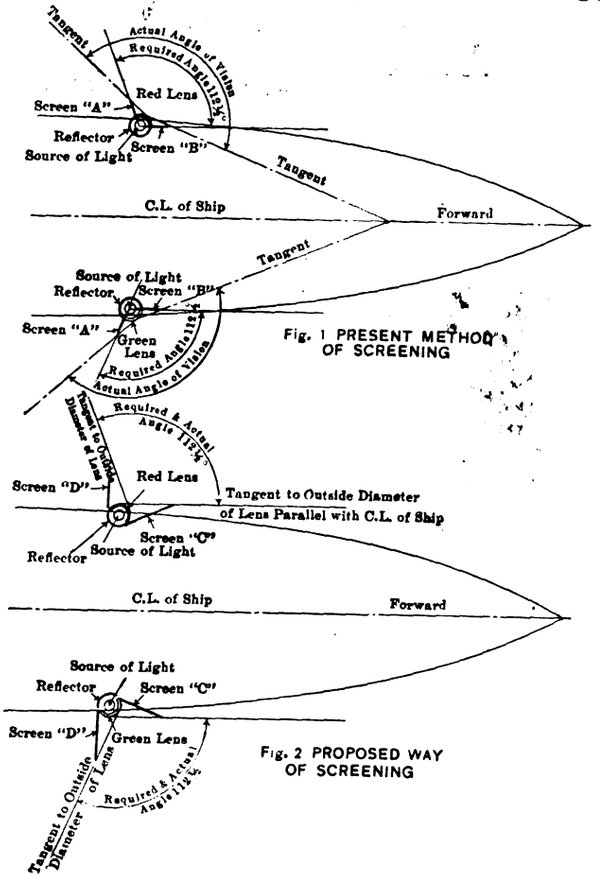
through the outside radius of the lens. This tangent should be at an angle of 112½ degrees with the centerline of the ship.

The same must be the case with screen *C*. The outer edge of screen *C* should touch the tangent passing through the outside of the lens.

This tangent must run parallel with the centerline of the ship. This shows clearly that any size of screen may be fitted as long as the outer edges do not project beyond or fall short of their respective tangents.

It is at once apparent that a slight increase or decrease of the lens radius changes the angle of vision accordingly,



and, inasmuch as very few lenses are of exactly the same dimensions, the screens will have to be carefully located for each individual light installed.

Careful observation of harbor craft and ocean-going vessels has shown that in many cases the lights were visible at a greater angle than that laid down by the laws of navigation, also the port light might be seen on starboard side and vice versa.

Increasing Stoke-Hold Efficiency—II*

The Flue Gas Analyzer

BY A. POHLMAN

IN Fig. 1 is shown a partial view of a flue gas analyzer. To simplify matters the solution jars used for *O* and *CO* analysis and the frame, or carrying case, of the instrument have been omitted. By referring to the sketch and mastering the simple details suggested in this article, any type of Orsat or analyzer, irrespective of its size or shape of glass parts, may be successfully operated.

As shown in Fig. 1, the neck of the burette, or gas-measuring device, is connected to the glass header *H* by means of rubber nipples. The burette *B* is inclosed in a glass water jacket *J*, which is filled with water and closed with a rubber stopper *R*, the object being to maintain a constant temperature in the burette. The lower neck of the burette is connected to the leveling bottle *C* by a piece of rubber tubing, the bottle being filled with water. To the left of the burette is the caustic jar containing an inverted glass bell *G*, which, in turn, contains a steel ribbon, as shown, or is loosely filled with steel wool. This jar is half filled with caustic solution and the neck of the bell *G*

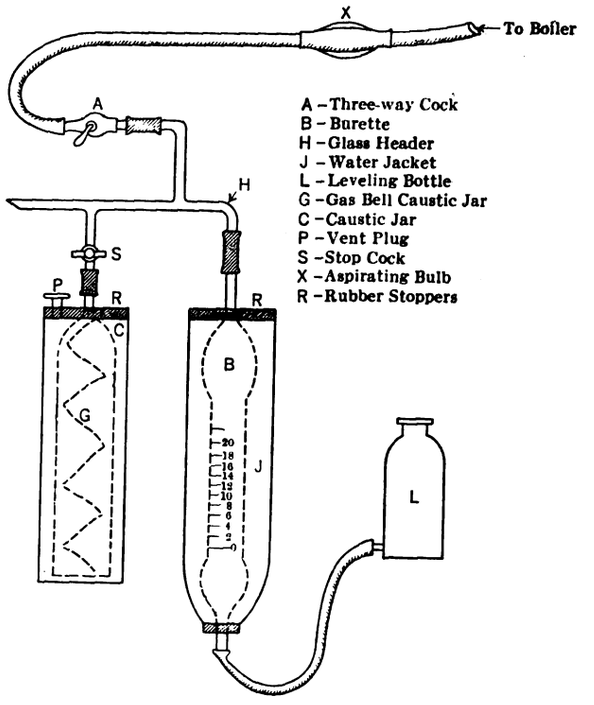


Fig. 1.—Diagram of Flue Gas Analyzer

connected to the header by a rubber nipple. The top of this jar is closed with a rubber stopper which has a vent plug *P*. This plug must always be removed when operating the apparatus.

Two more jars, not shown in the sketch, are provided with the instrument. They are exactly similar to the caustic jar and are connected to the header in the same manner, but they contain different chemical solutions. For reasons stated above, these are not taken into consideration at this time.

At the top of the header is a three-way cock *A*, on the under side of which is an opening to the atmosphere. To the nipple end a rubber tube leading to the gas sampling pipe is connected. In this tube a rubber bulb is inserted, which is used to pump the gas into the instrument.

OPERATION

To operate the instrument, the caustic jar is half filled with caustic solution and the stop cock *S* closed as shown. The three-way cock *A* is turned so that it opens to the atmosphere, as shown.

Raise the leveling bottle. As the leveling bottle is lifted the water in the burette will also rise and, acting as a plunger, will drive all the air in the burette ahead of it through the header and out of the vent hole in the three-way cock. When the water reaches a point in the neck of the burette just below the rubber nipple which connects it to the header, close the cock *A* by turning the handle so that it points up instead of down, as shown in the sketch. Remove the plug *P* from the stopper of the caustic

* Continued from December, 1919.

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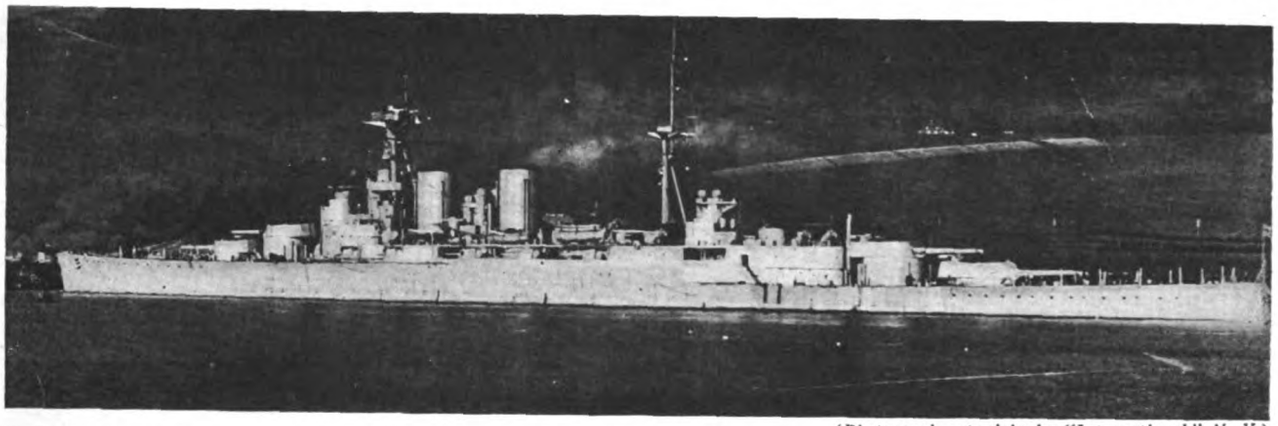


(Photograph copyright by "International," N. Y.)

British Battle Cruiser *Hood*. Length, 860 Feet; Beam, 104 Feet; Horsepower, 144,000; Speed, 31 Knots; Main Armament, Eight 15-Inch Guns

jar, open the stop cock *S* and gradually lower the leveling bottle. The water in the burette will then come down and, as it does, the caustic solution in *G* will rise. When the caustic has reached a point in the neck of the bell *G*, just below the rubber nipple connecting it to the header, close the stop cock *S*, then the caustic will remain in the bell.

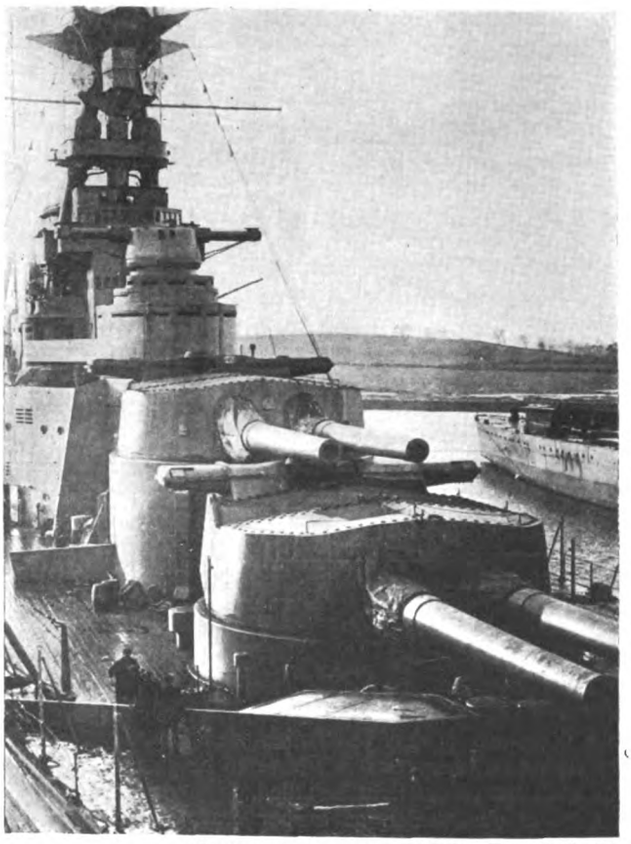
Next create a direct passage for gas from the sampling point, that is, in the uptake of the boiler, by turning the cock *A* so that its handle points to the tube leading to the sampling pipe. Operate the bulb and draw from the boiler a sample of the gases. It will be noticed that the water in the leveling bottle will bubble and a light haze will rise from it. This haze is the flue gas.

When this condition is reached, hold the bottle somewhat below the bottom of the burette, stop pumping and very steadily raise the bottle until the water in the burette stands at the zero mark on the scale. Close the instrument by again placing the handle of the cock *A* so it points up.

We now have a measured sample of gas locked in the instrument. Open the stop cock *S* and raise the bottle until the water in the burette reaches the rubber nipple and again shut the cock *S*. The gas has now been forced over into the caustic jar. The caustic will attack the CO_2 in the gas sample, but it will attack nothing else. In this way the CO_2 will be absorbed. Then open the cock *S* and lower the bottle. Do not pay any attention to the water in the burette this time, but watch the caustic instead, and the moment it reaches its former position in the neck of the bell *G*, near the rubber nipple, close the stop cock *S*.

Coming back again to the burette and leveling bottle: by raising or lowering the bottle, a place will be found where the water in the burette is at the level of the water in the bottle. Read the scale at this point and you will have the percent of CO_2. Part of the gas which at first filled the burette to the zero mark has been absorbed by the caustic and its place in the burette has been taken by water. As caustic absorbs only CO_2, the percentage thus absorbed can be read directly on the scale. As the water and acid levels will appear as curved lines, the reading should always be taken at the lower part of the curve.

As stated earlier in this article, the complete instrument has two other chemical jars in addition to the caustic jar One is operated with pyrogallic acid, which absorbs oxygen, and the other with copperous chlorine, which will absorb the *CO* or carbon monoxide. To get the *O* and *CO* the same sample of gas in which the CO_2 has been ex-



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Forward Turrets of the *Hood*

tracted is used. Simply open the stop cock over the jar and force the gas from the burette into the jar by raising the leveling bottle. In analyzing for *O* and *CO*, allow the gas to remain in the solution about five minutes before drawing it back into the burette for reading. The difference between the CO_2 reading and the next reading is the percentage of oxygen in the gas. The same process is repeated for *CO*.

SUGGESTIONS

Always make certain that all air is cleared out of solution jar bells and that it is replaced with the necessary solution well up in the neck of the bell.

Be sure to clear the burette of air by having the water well up in its neck before drawing the gas sample.

Never have more than one cock open at a time and make certain that all others close airtight.

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Development of Warrior River Barge Canal

BY MAJOR ROBERT S. THOMAS, CORPS OF ENGINEERS, U. S. A.

After nearly fifty years of investigation, experimentation, maintenance and progressive construction, the Federal government has provided for the southern coal and iron region of the Birmingham district and for the timber and farming sections of western Alabama a canalized river that offers for over four hundred miles facilities for navigation not possessed to so great a degree by any other system of inland waterways in the United States. This article gives a brief account of the development of this waterway, shows the volume of commerce which it carries and describes the development of transportation methods giving details of the present vessel equipment. A second article, to be published in the next issue, will take up the question of terminals and transfer facilities and future prospects for the commercial development of the waterway.

THE magnitude of the great Mississippi river system of inland waters, draining all of the basin between the Appalachian and Rocky mountains, north of Tennessee's southern boundary, and a vast area west of the Father of Waters, has obscured the public attention to the fact that this country possesses also a river system of no mean magnitude and extent draining a basin that extends from Western Georgia to Central Mississippi. This system finds its outlet to the Gulf of Mexico through the Mobile river and Mobile bay. The navigable waterways of this system are as follows:

The Mobile river with navigable depth of 27 feet (project depth of 30 feet soon to be provided) for about 5 miles from the mouth of Chickasaw bayou, the upper limits of the harbor of Mobile, and 17 feet for the remainder of the 45 miles from the mouth to the junction of the Alabama and the Tombigbee rivers, which join and form the Mobile river.

The Alabama river, with navigable depth of about 3 feet for 271 miles to Montgomery, Ala.

The Coosa river, which is formed at Rome, Ga., by the junction of the Oostanaula and Etowah rivers, and flows in a southwesterly direction through Georgia and Alabama for a distance of 282 miles, uniting with the Tallapoosa to form the Alabama about 22 miles above Montgomery, the present navigable depths at low waters being 4 feet over certain improved sections, 3 feet to Gadsden, Ala., and 2½ feet to Rome, Ga.

The Tombigbee river from its junction with the Alabama over the canalized stretch to the mouth of Warrior river near Demopolis, Ala., 185 miles, having a guaranteed navigable depth of 6 feet the year round and a practical depth of 8 feet except in the period of extremely low water. From the mouth of the Warrior river to Walkers Bridge in Mississippi, a distance of about 303 miles, the stream is not canalized and navigation, except at high water, is limited to shallow draft boats and rafting. For about four months in the year boats drawing 5 feet can navigate to as far as Columbus, Miss., 149 miles, but actually boats seldom go beyond Pickensville, Miss., 114 miles above the mouth. Federal improvement is limited to snagging and removal of obstructions.

The Warrior river, which has been completely canalized from its junction with the Tombigbee river near Demopolis for a distance of 131 miles to Tuscaloosa, Ala., where the name of the river changes to that of Black Warrior, though it is the same stream, thence 47 miles to the junction of the two forks of the Black Warrior, the Mulberry Fork and the Locust Fork, thence up these forks to Saunders Shoals on the Mulberry Fork, 36 miles, and to Nichols Shoals on the Locust Fork, 16 miles.

Thus there is provided a navigable waterway of a minimum 6-foot depth (practically 8 feet) for a distance of about 420 miles from the coal fields of Alabama to tide water at Mobile. Table I gives the location and other data for the locks in this system.

This improvement, carried out by the Government, has cost to June 30, 1919, for the earlier projects prior to the existing project:

For new work	$600,930	(£ 126,500)
For maintenance	50,000	(8,200)
Total	$650,930	(£ 134,700)
For the existing project:		
For new work	$9,367,564	(£1,920,000)
For maintenance	216,663	(44,400)
Total existing project	$9,584,227	(£1,964,400)

TABLE I. LOCATION AND DETAILS OF LOCKS

Lock No.	Distance from Mobile.	Nearest town.	Distance.	Width of chamber and greatest length available for the full width.	Lift.	Depth over sills at low water.
	Miles.		*Miles.*	*Feet.*	*Feet.*	*Feet.*
1	111	St. Stephens, Ala.	3	281.9 by 52	10.00	6.5
2	182	Pennington, Ala.	6	286 by 52	10.00	6.5
3	205	Oakchia, Ala.	5	do	10.00	6.5
4	231	Demopolis, Ala.	1	285.6 by 52	10.00	6.5
5	246	Cedarville, Ala.	5	do	10.00	6.5
6	267	Sawyerville, Ala.	5	do	10.00	6.5
7	282	Wedgworth, Ala.	5	284.7 by 52	10.00	6.5
8	298	Akron, Ala.	3	284.7 by 51.65	10.00	6.5
9	315	Powers, Ala.	4	284.7 by 52	10.00	6.5
10	362	Tuscaloosa, Ala.		286.6 by 52	9.86	6.5
11	362	do		286 by 52	8.50	6.5
12	363	do	1	286.2 by 52	10.50	6.5
13	370	Tidewater, Ala.		285.5 by 52	12.14	6.5
14	373	Searles, Ala.	8	282.1 by 52	14.00	6.5
15	380	Kellerman, Ala.	6	do	14.00	6.5
16	387	do	14	285.5 by 52	21.00	6.5
17[1]	388	do	14	do	63.00	6.5

Lock No.	Character of foundation.	Kind of dam.	Type of construction: Lock.	Type of construction: Dam.	Date of completion.	Actual cost of lock and dam.
1	Soft rock	Fixed	Concrete	Concrete	1909	$560,290.02
2	Hard clay	do	do	Timber crib, stone	1915	560,114.09
3	do	do	do	do	1915	609,622.80
4	do	do	do	do	1908	479,000.00
5	do	do	do	do	1908	501,000.00
6	Piles	do	do	do	1908	443,000.00
7	do	do	do	do	1903	225,600.00
8	do	do	do	do	1903	212,400.00
9	do	do	do	do	1902	202,440.00
10	Hard sandstone	do	Stone	do	1895	244,500.00
11	do	do	do	do	1895	170,000.00
12	do	do	do	do	1895	160,500.00
13	do	do	do	Stone	1905	203,700.00
14	do	do	Concrete	Concrete	1910	414,714.89
15	do	do	do	do	1910	430,233.87
16	do	do	do	do	1915	520,853.68
17[1]	do	do	do	do	[2] 1915	[2] 3,115,520.36

[1] Double lock.
[2] Opened to navigation in 1915. Now 99 percent complete 1, the remaining 1 percent covers cost of submerged land. Estimated cost. Payments for submerged lands not completed. Cost to January 1, 1918, $3,042,242.42.

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For the operation and care of locks and dams after completion of construction	$1,992,132	(£ 409,000)
Total cost of construction, maintenance and operation	$12,233,289	(£2,510,000)

At the present time it is costing about $250,000 (£51,250) per year for the operation and care of the system of locks and dams, and from $150,000 (£30,800) to $200,000 (£41,000) for snagging, dredging of bars, strengthening of dams by the deposit of heavy stone below dams, widening of channel at sharp bends by dredging and the construction of certain additional guide cribs and other items of new work and maintenance.

A recent act of Congress has provided for the placing of permanent flash boards upon certain dams, thus raising the pool of the dams two feet and actually providing for an 8-foot channel. The project width of 150 feet, wherever practicable, has been authorized. The work of installing the flash boards has been started and on several of the dams completed. Very satisfactory progress was made the past season in dredging out the bars where the 8-foot channel has narrowed, as well as in dredging at the sharp bends. To all practical purposes this channel now affords the guaranteed depth of 6 feet and a minimum width of 125 to 150 feet all the year round.

Commerce

The records of the commerce upon this river are not entirely satisfactory for the purpose of drawing definite conclusions. The method of procuring and reporting these statistics has varied from time to time, and it is not always clear as to exactly what portion of the traffic is through traffic and what is local. It is also believed that some of the earlier figures given have not taken into consideration the log rafts that are floated down this river in no inconsiderable volume. Some years the traffic was reported in bales of cotton and the remainder of the traffic estimated sometimes in tons, sometimes in tons and value, and sometimes in ton-miles. Subject to the foregoing remarks, the following table of the commerce on the Warrior-Tombigbee River System for the years 1916-1918 is given:

TABLE II

Calendar Years	Total Traffic, Tons	Value, Total Traffic	Coal, Tons
1916	457,109	$4,668,783	154,710
1917	580,788	5,891,861	158,076
1918	671,405	6,168,975	.....

Total Volume of Traffic

The high mark was in 1877 with a traffic estimated at over $10,000,000 (£2,050,000). The volume then declined to a minimum of 37,000 tons at a value that probably did not exceed $1,500,000 (£308,000). There appeared to have been a temporary revival of water traffic, culminating in 360,000 tons at a value of about $5,000,000 (£1,025,000) in 1900, followed by a collapse to 144,000 tons in the fiscal years 1901 and 1902, valued at about $2,000,000 (£410,000). Then followed a revival to 1909 with 639,041 tons, valued at from $9,000,000 (£1,845,000) to $10,000,000 (£2,050,000). This was followed by a gradual falling off to 270,000 tons in 1913, valued at less than $4,000,000 (£820,000). The recent years of 1916, 1917 and 1918 show a pleasing and progressive growth to 671,000 tons in 1918, valued at over $6,000,000 (£1,230,000). The statistics for 1919 are not yet available.

After a study of the commerce transported on this river and the failure of the volume and value of the traffic to respond to expenditures for the improvement, we must rather admire the courage and the far vision of the engineers who recommended and of those Congresses that made the liberal appropriations, rather than condemn the caution of those Congresses that failed to provide for the more rapid progress of this development.

The public at large or locally has not yet fully awakened to the possibilities and economies now possible from the full utilization of this project. The development of water transportation, then the decline of water transportation coincident with the development of railroads, and then the renewed development of water transportation in conjunction with and supplementary to the railroads are three normal steps in the national development of the transportation system of every nation. In view of these facts it would seem that this development has progressed even more rapidly than the ability and the will of the public to avail itself of this improvement and that the care and caution and time required have been fully justified by the stability and practical possibilities of this development as it exists today.

Development of Transportation Methods

The western river stern-wheel type of boat is still holding its own on this river as on other inland rivers of this country, and there are numbers of them in commercial use besides the snag boats and towboats belonging to the fleet of the United States Engineers and to the United States Railroad Administration.

The *Peerless*, a sternwheel packet boat of the Burke Packet Company, operates weekly, except at extreme low water, from Mobile to Selma, Ala., on the Alabama river. It is understood that they have all the business they can handle. They make all-way landings and handle a general cargo and passengers. Roustabouts are used for loading and unloading.

The sternwheel packet boat *John Quill* is operated by the Merchants Transportation Company, making weekly trips up the Tombigbee river as far as Demopolis, stopping at all-way landings, which are numerous. They are apparently finding plenty of business. They handle a miscellaneous cargo and a passenger service. Roustabout labor is used for loading and unloading on the river banks. At many of the landings are small warehouses and inclined tracks with one small flat car operated by cable attached to a hand windlass.

Data as to the volume of traffic and cost of operating these packet boats are not available. They seem, however, to be having a good business and are understood to be making expenses. With the general nature of the cargo in small lots to way stations and with the greater cost of labor, both unskilled and skilled, it is not probable that any large profits are made. The fact that these boats are operating is, however, a favorable sign and shows the need for water transportation and an awakening of public interest in inland waterways.

There are a number of western river type sternwheel towboats privately owned, operating principally in the handling of logs and lumber to and from the many saw mills along the river. Among these may be mentioned the *Tailers* at Akron, Ala., owned by the Black Warrior Lumber Company; the *Hale*, owned by John C. Webb and Sons, of Demopolis, and the *Baldwin*, owned by Captain J. Baker, at Tuscaloosa, Ala. In some instances the logs are rafted to the river bank near the saw mill, but generally they are loaded on barges by a derrick boat or by skids from the bank, and are towed to the mill, where they are hoisted out of the water by a stiff-leg derrick and steam-hoisting engine. There is still much timber standing, and this industry may be expected to thrive for many years to come.

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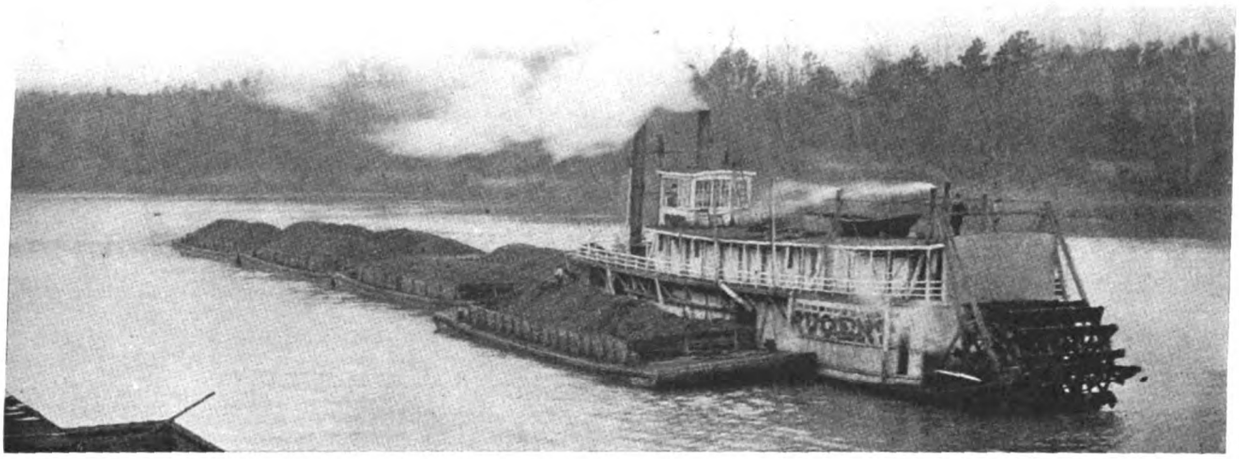

Fig. 1.—Steamer *Nugent* Leaving Tuscaloosa, Ala., with Tow of Seven Barges of Coal

THE PLANT OF THE UNITED STATES RAILROAD ADMINISTRATION—WARRIOR RIVER SECTION

When the United States Railroad Administration took over the operation of the Mississippi-Warrior waterways as a war measure they naturally did not delay the movement of coal until steamboats and barges could be designed and constructed to give the maximum service for minimum operating costs, but purchased what plant was available. This plant included three sternwheel towboats, western river type, the *Clio, Darling* and *Volcano;* forty-three open wooden coal barges, each 140 feet long (eleven of which are 24 feet wide and thirty-two are 25 feet wide, twenty-three are 8½ feet deep and twenty are 10 feet deep); five self-propelled steel coal barges (of which three are 220 feet long, one 200 feet long, and one 240 feet long; all are 32 feet wide by 8 feet deep); two unloading machines, locomotive-crane type operating 2-ton clamshell buckets, located at the transfer point at Mobile for transporting the coal from wooden river barges and self-propelled barges to one self-propelled barge for shipment to New Orleans by way of Mobile bay, Mississippi sound, Lake Borgee canal to the Mississippi river at Violet, near New Orleans.

The towboats and certain of the old wooden coal barges required extensive overhauling and repairs. Twenty of the wooden coal barges are new, having recently been constructed under contract by the Murnan Shipbuilding Company, of Mobile. The repairs to the old

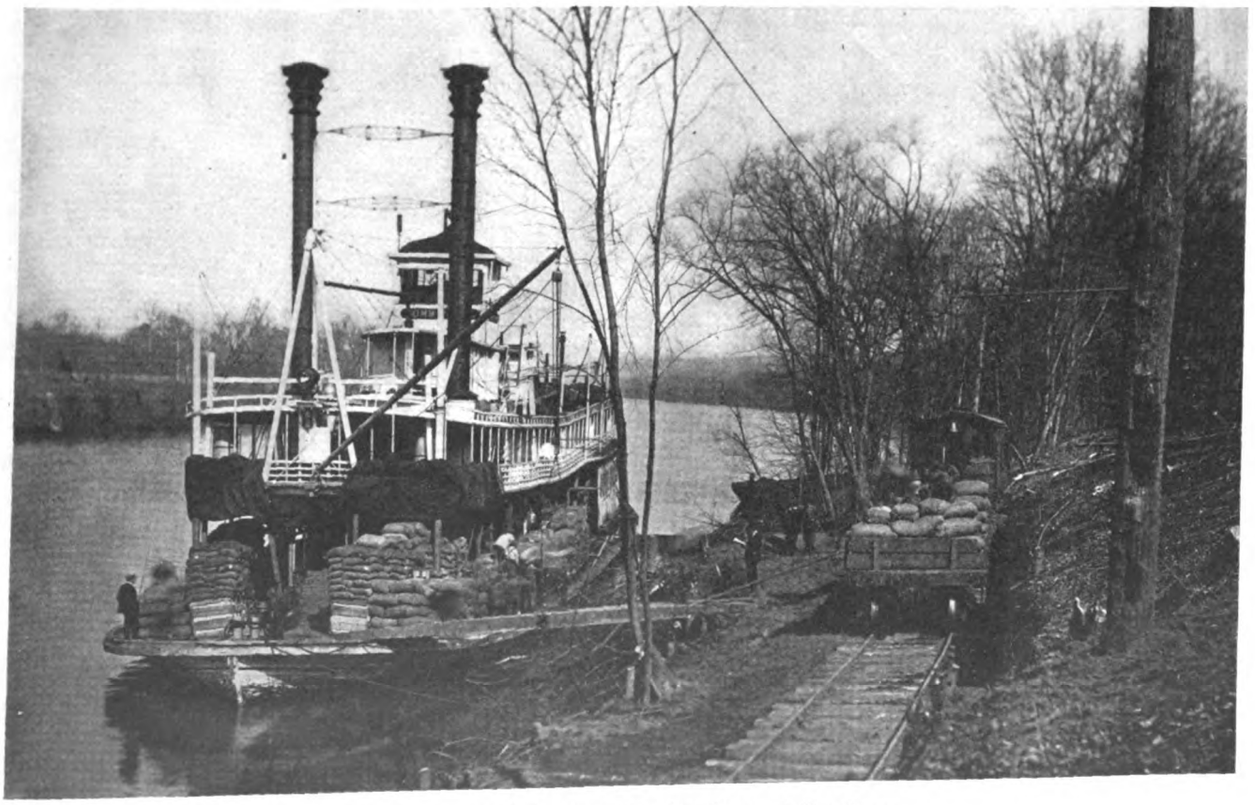

Fig. 2.—Steamer *John Quill* Unloading Cargo at Tuscaloosa

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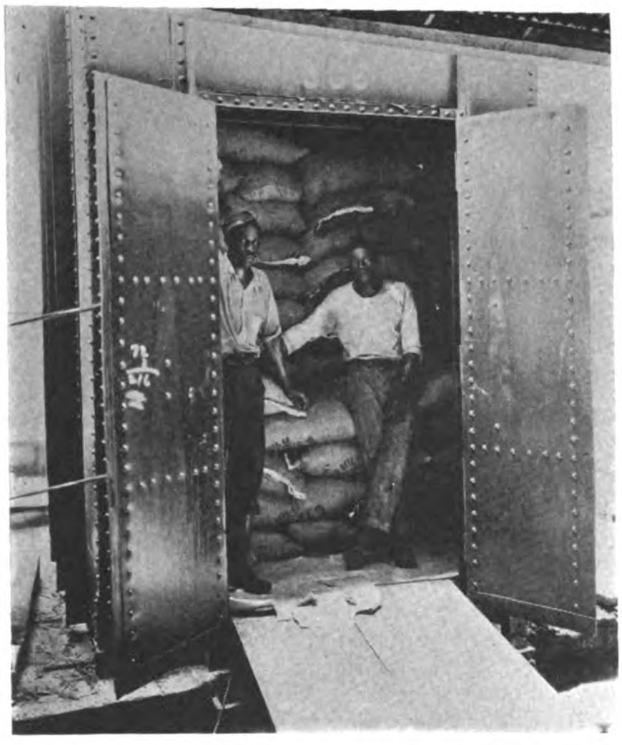

Fig. 3.—Steel Container Loaded with Sugar in Sacks

plant were made at the United States Engineer yards at Tuscaloosa and Pascagoula, the actual cost and overhead being reimbursed by the United States Railroad Administration.

In addition to the above-mentioned equipment, the Warrior section has twenty steel containers 8 feet by 8 feet by 9 feet, designed to fit on flat cars and barges, with wire cable in top for handling. They are also equipped with end ladders and top foot-ways, so that when placed on a flat car the car becomes to all purposes a box car. The doors to each container are double and can be locked, thus making the containers both weatherproof and thiefproof.

It is contemplated to use these containers especially for upstream shipments of such perishable commodities as coffee, salt, sugar, flour, grain and merchandise that will originate in New Orleans and Mobile and be shipped to such distributing centers as Demopolis, Tuscaloosa and Birmingham. These containers can be loaded either at the transfer points at Violet near New Orleans and at Mobile or at the factories and warehouses and then transferred by flat cars to the water terminals, where they can be loaded on the barges by derricks. It is proposed that these containers will be unloaded by derricks provided by the local interests. The empty containers will be brought back on top of the downstream load of coal. It is understood that 200 additional containers have been ordered.

Loaded with sugar, these containers hold about 10 tons net. Fig. 3 shows one of these containers loaded with sugar in sacks, showing the double doors and weatherproof and thiefproof advantages of such a container. Fig. 4 shows the containers on a flat car being loaded with sugar in barrels. Fig. 6 shows the containers being transferred from the flat cars to one of the self-propelled barges by means of a derrick. The derrick did not prove strong enough for the load, so that No. 4 self-propelled barge is now being converted to a derrick and conveyor barge for use at the transfer point at the New Orleans terminal.

Sternwheel Towboats

The sternwheel towboats have been operating from the mines to Mobile with the wooden barges loaded with coal in tow. They handle three and four barges per tow, breaking tow at the locks, the towboat and four barges

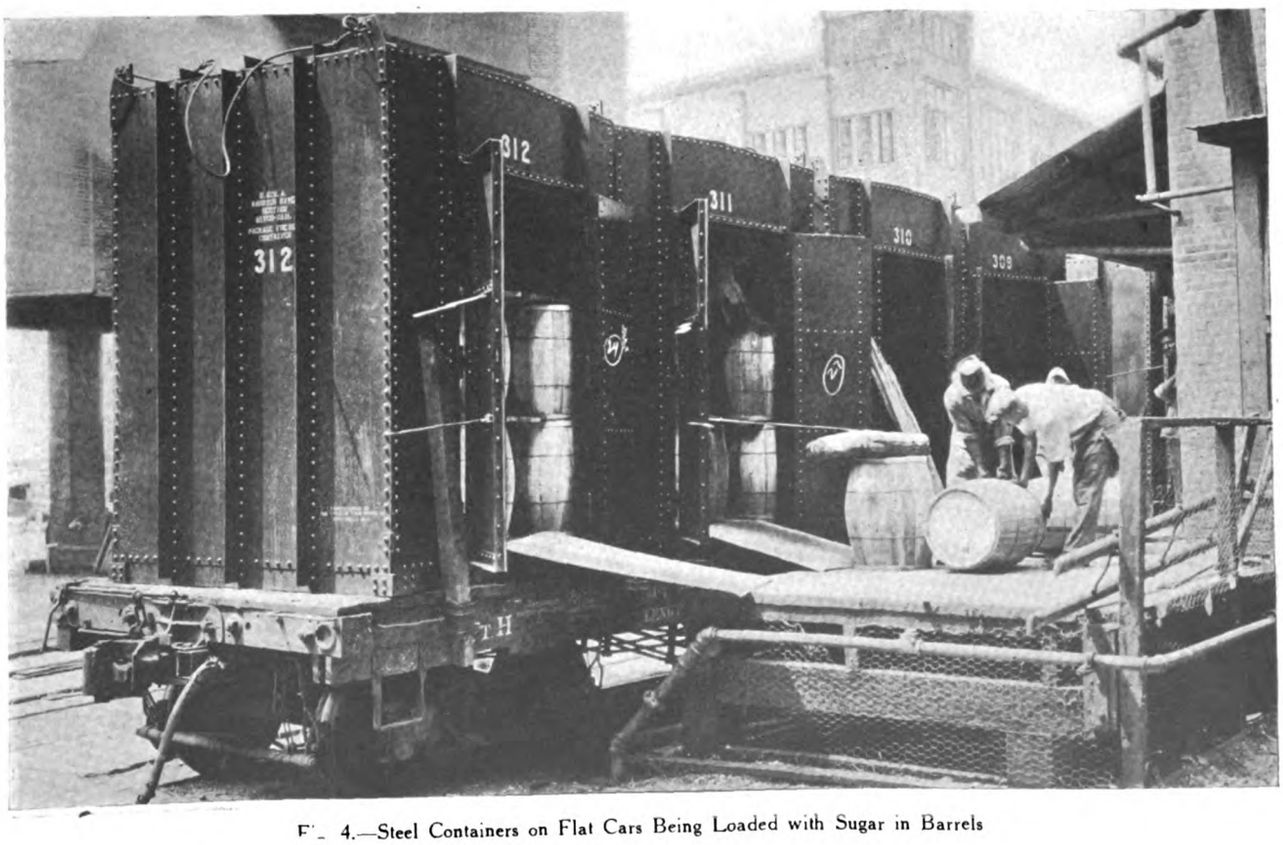

Fig. 4.—Steel Containers on Flat Cars Being Loaded with Sugar in Barrels

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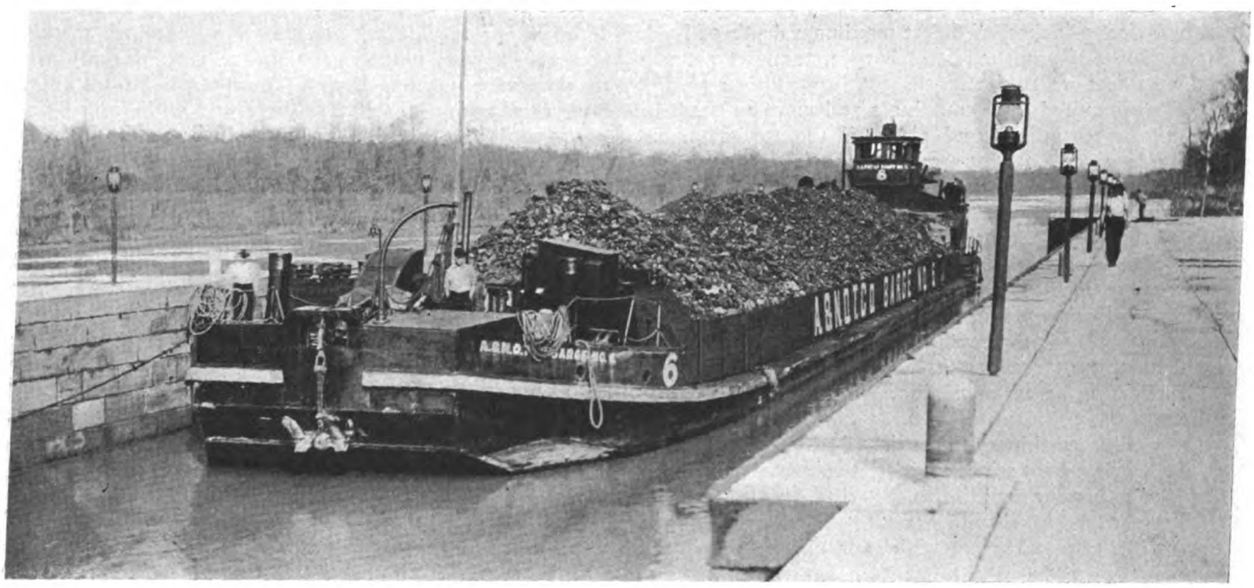

Fig. 5.—Self-Propelled Barge *No.* 6 in Lock No. 11, Black Warrior River, Ala.

being passed in two lockages. For some time past it has been the intention to experiment with the plan of having the *Darling* and the *Clio* bring four barge tows from the mine to below lock No. 1, there to be assembled into eight barge tows and brought to Mobile over the wider and less restricted river by the larger towboat *Volcano*. Recently these cargoes of coal have been supplemented with a top cargo of large dimension timbers for export purposes.

SELF-PROPELLED BARGES

Of the six self-propelled barges, four are operated from the mines to Mobile and one transfers from Mobile to New Orleans, the coal being handled by clamshell buckets at Mobile. Barge No. 4 is being converted at New Orleans into a derrick and conveyor barge. Nos. 1, 2, 3 and 4 are 200 feet long; No. 5 is 240 feet long, and No. 6 220 feet long. All are 32 feet wide and 8 feet deep. Their estimated carrying capacities are 735 and 850 tons on a 6-foot draft.

The vessels are constructed of steel plates and angles, and the load is carried on deck. Each barge carries its own power, which is a gas producer, and two producer-gas engines of 75 horsepower each. The fuel used is nut coke, and each barge consumes about 1¼ tons per day. The engines run in opposite directions, make about 300 revolutions per minute, are about 12 feet apart and drive 3-blade propellers 42 inches in diameter with 30 inches pitch. Each barge has three rudders, the middle rudder balanced.

These barges handle very well, but have insufficient backing power. One of the upper lock gates was recently rammed by one of these barges, but without material damage.

NEW EQUIPMENT

Besides the twenty open coal barges 140 feet by 25 feet by 10 feet recently constructed by the Warrior Shipbuilding Company, the new equipment now under construction includes:

(a) Three steel tunnel-type towboats, 140 feet by 24

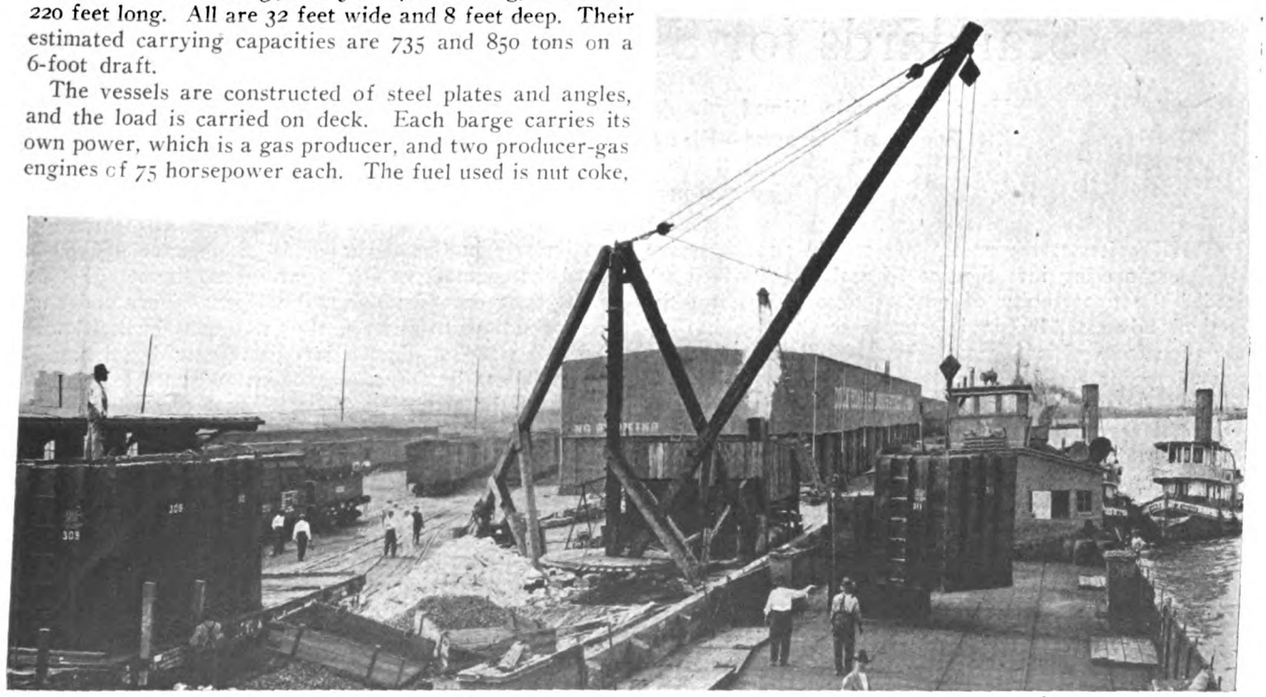

Fig. 6.—Transfer of Steel Containers from Flat Cars to Deck of Self-Propelled Barge at New Orleans

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feet by 8 feet 9 inches, of 6 feet maximum depth of hold.

(b) Four self-propelled steel barges, tunnel type, 280 feet by 49 feet by 10 feet.

(c) Two hundred steel containers and more as needed.

Detailed descriptions and plans of the towboats and barges are given on page 674 et seq., of MARINE ENGINEERING for October, 1919. The specifications provide for a "single deck, shallow draft, twin-screw tunnel towboat, built of steel, with a continuous deck house about 112 feet long. House on deck to accommodate major portion of crew, galley, mess room, lavatories, coal bunker and machinery. House on the upper deck forward to contain living quarters for the captain and a spacious pilot house. Total number of crew, 16.

"Rudders to be arranged forward and aft of the propellers.

"Propelling machinery to consist of two 400-horsepower, vertical, triple-expansion engines, two watertube boilers and the necessary auxiliaries.

"Vessel to be fitted with one mast to carry light heavy towing bits, capstans, cleats, fairleads, chocks, fenders and guards.

"Vessel also to be fitted with electric light plant, steam steerer and complete outfit to pass United States Inspection requirements."

The two propelling engines are to have an 18-inch stroke and diameters of 10¾ inches, 17 inches and 27 inches for high-, intermediate- and low-pressure cylinders respectively. They will be designed and built to operate with a working steam pressure of 225 pounds gage per square inch, at a piston speed of 600 feet per minute and develop 400 indicated horsepower at a normal speed of 200 revolutions per minute.

The propellers are to be four-bladed, twin-screw right and left hand, made of cast iron 6 feet in diameter and about 5 feet 6 inches pitch.

The two boilers are to be of the marine watertube type, designed for at least 225 pounds per square inch working pressure, approximately 1,400 square feet of grate area, to evaporate not less than 15,000 pounds of water per hour at 225 pounds per steam pressure, with forced draft of 10,000 cubic feet of air at 1 inch water gage and feed water at 200 degrees F. The boilers are to be hand-fired.

The auxiliary machinery includes a condenser with a centrifugal circulating pump driven by direct-acting 6-inch by 6-inch engine; an air pump; two feed pumps of the vertical simplex extra heavy type, 5-inch water cylinders, 8-inch steam cylinders, 12-inch stroke; fire and bilge pump; sanitary pump; feed water heater; a 2-inch injector for each boiler, etc. For feed water there is provided in the hold forward of the boiler room bulkhead and aft of the engine room a 40-ton tank for fresh water. River water is to be used for boiler feed only in emergency. The boat will be steam-heated and lighted with electricity.

TWIN-SCREW STEEL TUNNEL SELF-PROPELLED BARGES

The four steel self-propelled barges 280 feet by 49 feet by 10 feet with maximum draft of 7 feet are each to be equipped with two vertical expansion engines with cylinders 10¾ inches by 17 inches by 27 inches diameter by 18 inches stroke, working at 225 pounds steam pressure and developing 400 horsepower at 200 revolutions per minute as described for the towboats. The boilers and auxiliaries are in general similar to those for the towboats.

An interesting feature about these self-propelled barges is their sizes, designed to get the maximum practical benefit permitted by the size of the lock chambers, which have the controlling dimensions of 281.9 feet available length and 51.65 feet available width. There is being discussed from time to time the question of whether or not it would be practicable to use boats through these locks with a width of 50 feet or even 50 feet and 6 inches.

(To be concluded.)

Standards for Ship Construction

How Workable Standards Are Determined—Data Presented in Form of Graphs—Planning and Scheduling Methods

BY CREIGHTON CHURCHILL*

THE writer was recently engaged in an exhaustive engineering investigation of a shipyard which afforded the opportunity of putting to practical use the methods advocated by him in a paper on "Steel Ship Construction from a Management Viewpoint," read at the last annual meeting of the Society of Naval Architects and Marine Engineers. The results of this investigation indicated the urgent necessity of setting up standards to work to and the data secured, worked up in the form of graphs, present the subject to the readers of MARINE ENGINEERING in a way that cannot fail to bring to their attention the fact that such a necessity really exists and is worthy of the most serious consideration by shipyard executives.

Standards are the basis of intelligent estimating. Without them estimating can only be based on past performance, a method that fails to consider all the elements involved. Prices quoted on such a basis are not sufficient, particularly in the newer yards which have not yet entered the competitive field or are about to enter that field with young organizations and only experience under normal conditions to rely on. For example, during the war, expense was less than a secondary consideration. This was followed by forced economies and uncertainties as a result of the armistice. Due to these two extremes, the shipbuilding industry in this country today is in anything but a normal state. The reconstruction period looked forward to immediately after the cessation of hostilities has hardly yet got a fair start. The business world is still "topsy-turvy," and nothing but faith in the belief that eventually a way out will be found is keeping the wheels of industry moving.

Under such conditions it behooves the executive to keep in close touch with events from day to day. In any manufacturing industry the simplest and most effective way to do this is to set up reasonable standards and then exert every resource of the organization to make them accom-

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plished facts. It will not do to establish standards in a haphazard way or by what some other plant in the same business has done. They must come from an analysis of actual existing conditions and of necessity should change as conditions change, having due regard for fair play with labor. For example, a standard set for machining a forging with high-speed steel would not hold if ordinary tool steel were used. In the same way standards set for an old-established organization composed of tried and skilled men would not answer in a new organization which has not yet found itself. Yet both should have standards in order that the executives may keep in close touch with daily activities. No greater mistake can be made than that of setting up standards which are unattainable. Such men employed being the same. The question, therefore, resolves itself into one of finding an attainable standard of man performance, the answer to which is found in the records of past performance, intelligent estimating and a careful study of existing conditions.

As a guide, but only as a guide, known performance in other yards is useful for the simple reason that it may help to account for many things and point the way to weaknesses to be corrected. With this purpose in view, the Emergency Fleet Corporation published many records of performance, and there is little doubt that such a policy had a very good effect. Aside from its aspect as a sporting proposition, it gave many executives food for serious thought, which, in itself, is usually productive of results.

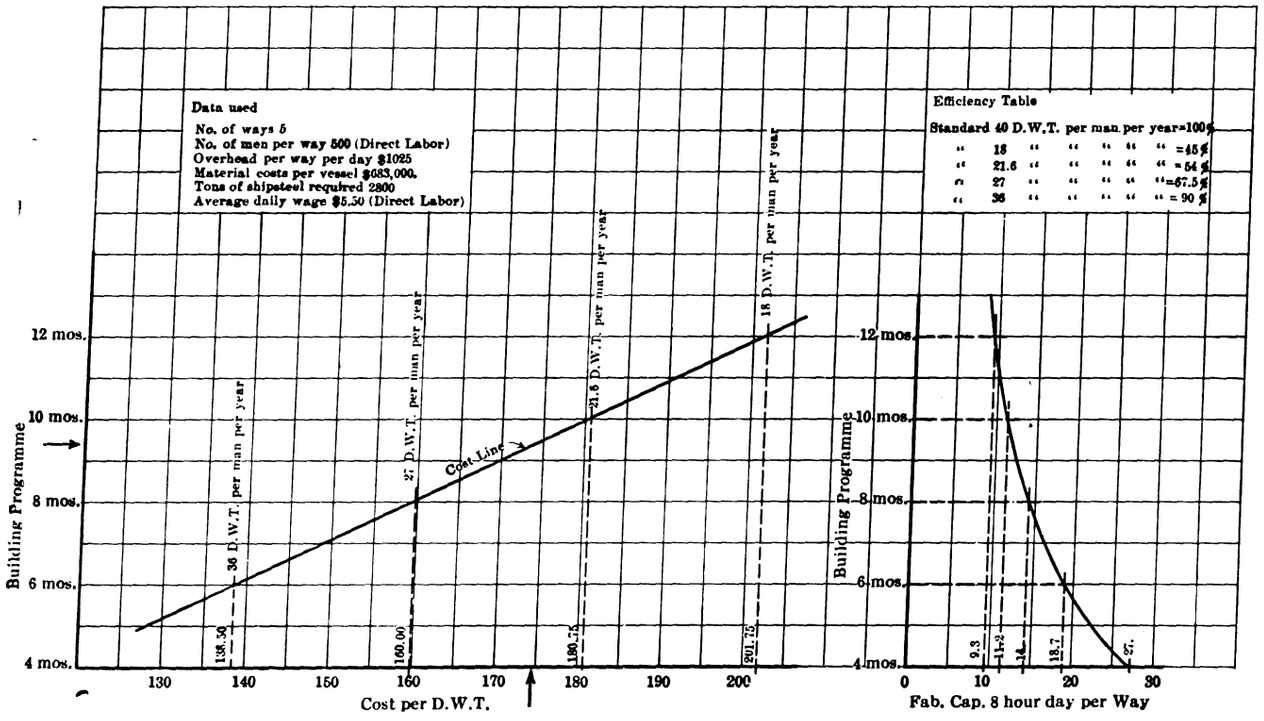

Fig. 1.—Chart Showing Relative Costs of 9,000 Deadweight Ton Cargo Vessel for Different Times of Building, the Number of Men Being the Same

a proceeding is unfair any way it is looked at and is bound to discourage not only the workmen but the sub-executives on whom so much depends.

Shipyards, in spite of the generally unsettled conditions, are in a very favorable position, due to the fact that ships are needed now. This does not mean that orders for them will be placed regardless of cost. In fact, quite the contrary is so and orders are placed only after the most careful consideration. This means that the shipowner is going to get what he wants as a result of keen competition, which, in turn, means that the industry as a whole is on a purely competitive basis and the yard that knows its business best is going to get the work.

As an example of this, attention is called to Fig. 1, which shows the relative costs of a 9,000 deadweight ton cargo vessel for different times of building, the number of men employed being the same. In other words, with the building time standardized, some idea can be secured of what the men must do in the way of fabricating, erecting and riveting. These, in turn, will be standards in order to meet the building programme. Naturally, in this particular case, the question of time required to build the ship is entirely a matter of man efficiency, the number of

Such serious thought as was developed might have been called by different names, but there can be little question that it had to do with "standards" in some form or other. Even as a sporting proposition—the desire to beat the other fellow—a mark is set up to shoot at, which, for the time being, is the standard—the goal which it is hoped will be reached, if not beaten.

Standards are logical as well as psychological—logical because something definite is set up to be attained, and psychological because it is human nature to have some curiosity about the accomplishment of others in the same line of work. An example of this in current shipyard practice is to play one boat foreman against another to speed up hull construction. This is introducing the sporting element; but, if not accompanied by a set of standards covering the various elements of hull construction, the onus falls entirely on the boat foreman, whereas the management should bear its share. By having, in the first place, a standard method of hull construction backed up by standards of performance for the men, the sporting element can still be retained, but each boat foreman will be relieved of the necessity of *both planning and executing his own work*. In other words, if the management does

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its part, the boat foreman is free to exercise his legitimate function, which is to execute.

As an illustration of how such methods work out in practice, a personal experience of the writer may not be amiss. While directing the installation of planning and scheduling methods in a large New England industry some years ago some difficulty was experienced in securing the co-operation of a departmental foreman, largely due to the fact that the man was very much overworked. It had been the habit of the sales department to feed him with orders affecting his department as fast as they came in and hold him responsible for keeping delivery promises made without consulting him. A large part of his time was taken up at the telephone answering "kicks," and the balance in an attempt to shuffle his orders to get the best results. The situation can be well imagined when it was found that something like 85 percent of the orders on his desk had a red "rush" tag attached, and the total of all his orders meant over two weeks' output. His opposition to more modern methods was overcome, and after some two or three months' operation under planning and scheduling, outside of his own department, he said to me, "Mr. Churchill, it seems like I'd lost me job, barring seeing that them ginks and harps do their work." Incidentally, the output of his department was increased 40 percent and costs reduced 23 percent as a direct result of the methods installed.

Planning and Scheduling Comes First

The basis, of course, for this improvement was standards, which were carefully worked out after planning and scheduling were introduced, which, in turn, brings up the very important point that standards cannot be definitely set until after the necessary preliminary work of planning and scheduling has been done. This is but another way of saying that standards in themselves will not accomplish the best results. Their value is largely enhanced when all elements of an industry are properly co-ordinated. This is obvious, if account is taken of the delays caused by one department failing to supply material to another when wanted. These unforeseen delays, when reduced to a minimum by effective methods of planning and scheduling, release productive time, and hence enable standards to be set that otherwise would appear unattainable, if referred to past records alone. This indicates the reason for doing the planning and scheduling work first. Estimates will be similarly affected, hence the desirability of proper standards.

To establish proper standards takes time and, as a general rule, necessitates the employment of properly qualified experts to direct and supervise the work involved, which must be done without interrupting current activities or causing any confusion. While strongly advocating the necessity for such work in shipyards, based on the results of many years of experience in other and varied industries, it fortunately happens that data are available that can be used to advantage if properly applied, though the results obtained should in no sense be considered the best obtainable. Their use in any yard may be considered a short cut to better but not best results, and as such are worthy of consideration from a competitive viewpoint.

Use of Data

Referring to Fig. 1, which, it should be remembered, applies to a particular yard building a certain type of cargo ship, the "cost line" is plotted from known conditions, as indicated under "Data used." Reference to the paper "Steel Ship Construction from a Management Viewpoint" and Standard Practice Bulletin No. 17, published by the Fleet Corporation under the direction of the writer, will reveal the fact that the average production of a number of yards for nine months of 1918 was 35 equivalent deadweight tons* per man per year and that the best of these yards showed an average of 45 equivalent deadweight tons per man per year. The average production of sixty-seven yards, that being the total number building steel ships, was a trifle better than 19 equivalent deadweight tons per man per year. Obviously, it would not be reasonable to set up any of these averages as a standard for any particular yard unless something were known of the conditions at that yard. On the other hand, if conditions were known or could be developed by investigation, steps could be taken to establish a tentative standard that would be workable through plotting the yard's cost line.

Tentative Standards

In the case in point the production, based on results obtained for September, October and November of 1919, indicated very clearly what could be expected under normal operating conditions with certain faults corrected. The existence of these faults, by the way, was recognized by the management, and they are now being remedied through expert advice and assistance. Taking it for granted that the remedy will produce the expected results, there was no hesitation in arriving at a tentative standard of 27 deadweight tons per man per year. Having arrived at this conclusion it is a simple matter of calculation to set overall standards for fabricating, erecting and riveting, and from these in turn set up gang or machine or man standards. This done, the means are at hand for referring daily performance to standard performance in any one of several ways. The writer prefers graphs, rather than records, as they tell the story at a glance. The records are available, if needed, to investigate any particular occurrence.

Minimum Cost Line

Fig. 2 is the same yard with the graph worked out to fulfill certain assumed standards and to develop a "minimum cost line." The number of men employed is determined by standards required and the fabricating capacity is supposed to vary with the building programme. The "cost line" from Fig. 1, transferred to this graph, is illuminating in many ways, but principally as showing the difference between what is and what might be, if all the elements of this particular yard were properly adjusted. Fig. 2 is, of course, only practical within certain well-defined limits, such, for instance, as erecting no more steel than it is possible to handle with efficient crane service or keeping the equipment of the fabricating shops from being excessive. Within its limits, however, it can be used to good advantage to determine ultimate standards. By plotting actual cost lines thereon from time to time, some idea of the yard's progress toward perfection may be gained. As stated in reference to Fig. 1, please bear in mind that Fig. 2 is also for a particular yard building a certain type of ship.

Fig. 3 is a graph showing the number of men per way (direct labor) at different man efficiencies and building programmes. It is useful for the purpose of indicating the reduction in time and cost due to increased man efficiency and pointing to the necessity of making every effort to increase this efficiency. In the particular case under discussion there is a variation in building time of over

* Equivalent deadweight tons means production in terms of a 7,500 deadweight ton cargo vessel. This was the method used by the Fleet Corporation to reduce output of different yards to a common basis. In the case of a 9,000 deadweight ton vessel, 45 equivalent deadweight tons is equal to 50 actual deadweight tons.

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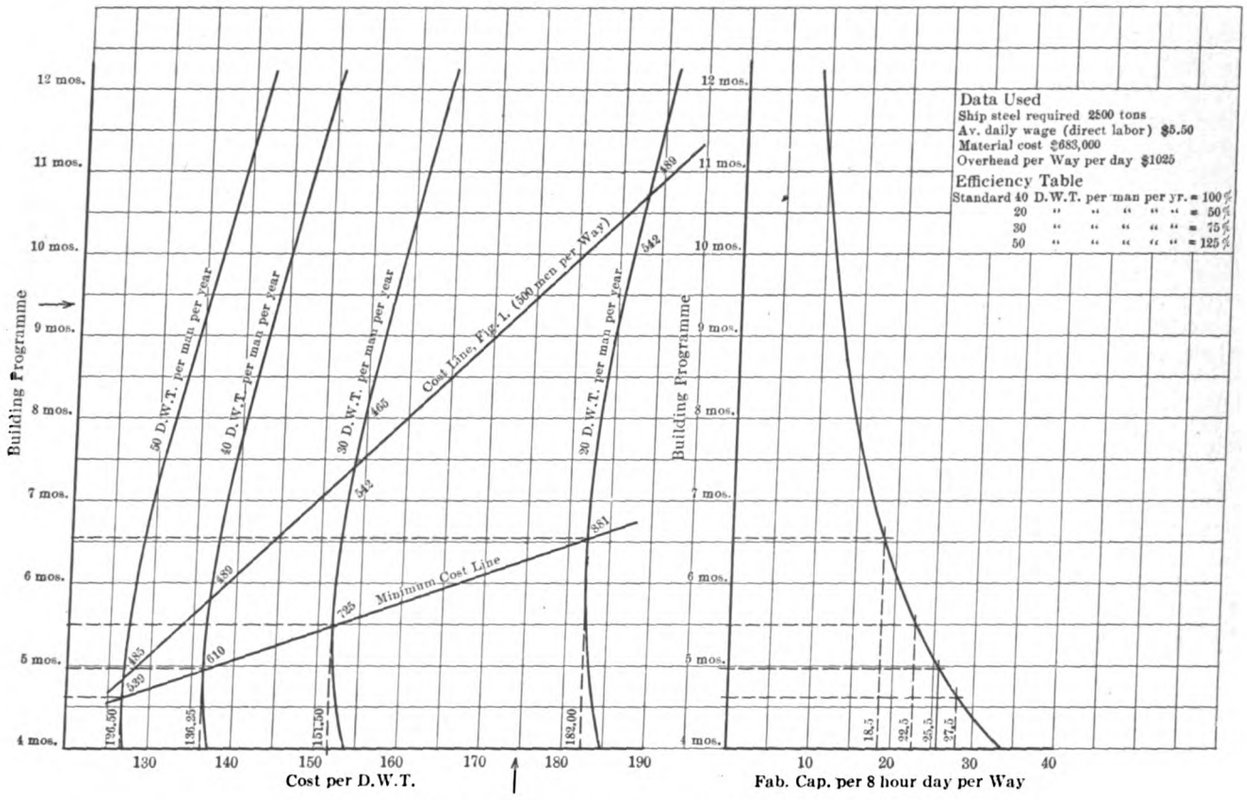

Fig. 2.—Chart on Which Minimum Cost Line Is Developed

three months between man efficiencies of 20 deadweight tons and 30 deadweight tons per man per year. Reference to Fig. 2 will show the difference in cost to be a trifle over $29 per deadweight ton. With such results well within the bounds of practical accomplishment, is it not ordinary business acumen for executives to be in possession of such information?

In other words, why not make, or have made, an "engi-

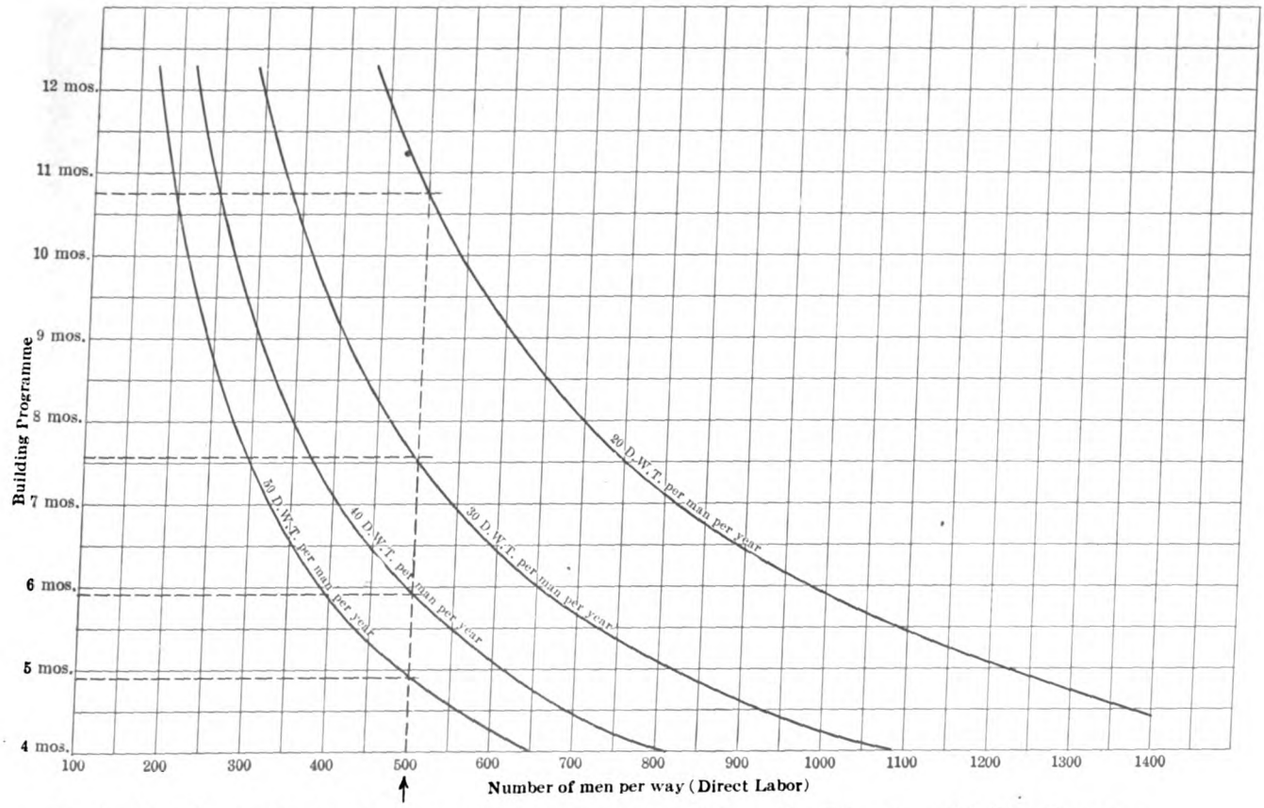

Fig. 3.—Chart Showing Number of Men per Way (Direct Labor) at Different Man Efficiencies and Building Programmes

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neering appraisal" to determine existing conditions and utilize the knowledge thus obtained to set up standards for the purpose of more economical construction and greater profits? The yards that do this will certainly be in a position to enter the competitive field knowing their limitations, and therefore will be less liable to enter into losing contracts. On the other hand, such an "engineering appraisal" will show conclusively that certain results can be predetermined, which is far more safe and satisfactory than depending on what is or might be accomplished at some future date. It is the difference between knowing certain things with reasonable accuracy before the event and taking a chance that they will come out as desired, which is but another way of saying that it is better to work to standards suited to actual conditions than to attempt to get results that a careful investigation would show to be next to impossible.

For example, referring to Fig. 2, it will be seen that at 20 deadweight tons per man per year the most economical cost per deadweight ton is $182 with a building programme of 6½ months. To accomplish this will require 881 men per way. With 500 men per way at the same rate of output the cost per deadweight ton will be $188.25 with a building programme of 10¾ months. Knowing this, the shipbuilder would be able to offer delivery with reasonable assurance of avoiding penalties, whereas without such knowledge he might be influenced to offer shorter delivery in order to secure the business and take a chance on the penalties.

Results of an "Engineering Appraisal"

Supposing this was actually done, he is asking his yard to show results that it has never accomplished. On the other hand, with graphs before him, as a result of an "engineering appraisal," he would know at a glance that in order to make the promised delivery he would have either to put on more men or to bring up the output per man of his present force. Presumably he would know which of these two courses to take, but without the graphs before him he might easily take the wrong course, with more or less disastrous results.

Assume, for the sake of argument, that without the graphs he decided to put on more men, which is what the ordinary executive will do to increase output. He would not know where to stop until the records came in showing desired results. With the graphs before him, however, he could see at a glance, Fig. 3, that if he can maintain an output of 20 deadweight tons per man per year and wants to make delivery in 9 months, he would have to put on 610 men per way, an increase of 110 men per way over his regular force of 500.

On the other hand, assume he decided to force the output with the original force, without the graphs to guide him. As construction progresses he is taking long chances and perhaps losing valuable time unless the driving methods are successful. Supposing they are not, he will soon reach the point where he will have to put on more men or work overtime. In other words, he is compelled to change his original plan and resort to one forced upon him to prevent or minimize a loss. By his own acts he creates an emergency, whereas a complete and thorough knowledge of all the contributing factors of the industry, as developed by the particular form of appraisal advocated, would, to say the least, tend to minimize the chances of such a condition.

The writer especially wishes to impress upon the readers of Marine Engineering, and upon shipyard executives particularly, that what he advocates is not theory in any sense of the word. It is simply applying methods used with more than a fair degree of success in other industries to that of shipbuilding. It is a development of the generally accepted idea of some years' standing that management in industry has well-defined responsibilities and that labor alone is not wholly chargeable with everything that goes wrong. It would be utterly foolish, if not impossible, to install boiler and engine foundations in a ship without working up the details from the boiler and engine drawings. By the same method of reasoning, why should not a knowledge of all the details of an industry be of value when the data are available to work them up?

Basis of True Standards

Progressive executives of today are a unit in supporting the principle of working to standards, provided they are set up as a result of proper study and investigation. False standards or those established on incomplete information usually do more harm than good and those set up by averaging past performance are misleading, to say the least. The former are more or less guesswork, and the latter are not really standards at all, although they serve the purpose of predetermining costs at that rate of output and under certain given conditions. A real standard implies results under most favorable conditions; consequently, conditions should be the first point of attack. When they are adjusted satisfactorily, then, and then only, can data be secured on which to base working standards that will mean anything. As a matter of fact, the adjustment of conditions to the most satisfactory point is by far the largest and most important factor in the work of developing standards. It frequently happens that it is necessary to make radical changes in the organization of an industry before conditions can be made the most satisfactory.

The usual method of arriving at standards has been to follow certain well-known principles of management involving the introduction of systems of production and material control, and after these have become well established to set about securing information on which to base standards. There can be no possible objection to this method, provided sufficient time is allowed properly to introduce the new systems without disrupting the organization and thereby affecting production. Assuming that ample time has been given, the result is that ultimate standards are set up which represent perfection in a practical sense. It so happens that many executives do not have the patience to permit the work to be carried out along these lines, believing that quicker results should be obtained, or, at least, that the way to improvement should be clearly enough indicated as the work progresses to enable them to take current advantage of it. In this they are perfectly correct and almost immediate results can be accomplished by the method of tentative standards developed by the writer and applied in several cases in the shipbuilding industry.

What Standards Indicate

The method involves an "engineering appraisal," which is an analysis of records and more or less investigation to show just *what is being done* and then working from this to indicate *what should be done*. Please note that the word "indicate" is used advisedly, for the reason that what should be done is not necessarily what can be done. The idea is to set up empirical standards to show what might be possible in the way of improvement by comparison with what is being done. These empirical standards are determined in consultation with the management. In the process of analyzing records accompanied by original in-

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OXYGEN 667 OXYTOCICS

composed again into barium oxide and free oxygen. This economic process has been worked on a large scale in various places. But since the early years of the twentieth century oxygen has been chiefly manufactured by the Linde process, which consists in liquefying air and subjecting it to fractional distillation by means of a suitable rectification column (see DISTILLATION), which readily yields an oxygen that is 98 or 99 per cent pure. To a much less extent, at present, oxygen is manufactured by the electrolysis of water.

Oxygen (symbol, O; atomic weight, 16; see ATOMIC WEIGHTS), is a colorless, odorless, and tasteless gas which has been condensed to a pale steel-blue, transparent liquid, boiling at −181.4° C. and freezing to a white solid at −235° C. Compared with air as unity, oxygen has a specific gravity of 1.1504, and it is the least refractive of all gases. Oxygen is slightly magnetic, which property is diminished or temporarily suspended by elevation of temperature. When examined through thick layers oxygen has a bluish tinge of color. It combines directly with most of the elements. (See OXIDES.) It is sparingly soluble in water, and nearly all natural waters contain oxygen in solution, which can be completely removed by boiling in vacuo. This dissolved oxygen is necessary to sustain the life of fish. In the pure state oxygen may be inhaled, for a time, with impunity, and it even acts as a tonic or exhilarant. Its long-continued respiration, however, is harmful. In pure oxygen bodies burn with much greater brilliancy than in common air. See COMBUSTION.

Oxygen has been used successfully to maintain air in a respirable condition, as in diving bells, submarine vessels, etc., and its use has been suggested for the revivifying of the atmosphere in public halls. It finds extensive application, in connection with hydrogen or illuminating gas, in the production of the oxy-hydrogen flame. (See DRUMMOND LIGHT; OXY-HYDROGEN BLOWPIPE.) It is also used in the bleaching of paper pulp, in the oxidation or thickening of oils which are used in the manufacture of varnish and oilcloths, for the purpose of hastening the maturing of spirituous liquors, and in the manufacture of ozone. But by far the most extensive use of oxygen at the present time is, in connection with the oxyacetylene flame, for welding and cutting metals. Consult: Jörgensen, *Die Darstellung des Sauerstoffes* (Stuttgart, 1907); Thorpe, *Dictionary of Applied Chemistry, Special Reference to the Industries* (published by the Carnegie Institution, Washington, 1912); Georges Claude, *Liquid Air, Oxygen, Nitrogen* (Philadelphia, 1913).

OXYGEN. [illegible] used, both [illegible] three ways: [illegible] by dri[illegible]

pneumonia, when there is danger to life from deficient aëration of the blood, in the chronic bronchitis of old people, and for the resuscitation of victims of coal-gas asphyxiation, oxygen gas is of very great value. It will allay the oppression and dyspnœa in phthisis and other wasting diseases. It acts as a direct stimulant to the respiratory mucous membrane and has a beneficial effect on the heart and respiration. When prolonged anæsthesia is necessary, oxygen is often given in conjunction with the general anæsthetics, to relieve cyanosis and as a safeguard against cardiac or respiratory failure [illegible] ture of nitrous-oxide gas and oxygen [illegible] one of the safest general anæsthetics. The use of oxygen in [illegible] valuable opinions and [illegible] A. H. Smith, of [illegible]

DIOXIDE.

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POUND BL [illegible] which hy [illegible] flame ha [illegible] This a [illegible] of Phi [illegible] hydr [illegible] high [illegible] Bu [illegible] is [illegible]

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vestigations primary faults are sure to be brought to light and open the way for immediate corrective measures. By using judgment as to the effect of these corrective measures tentative standards can be set up which immediately give the organization a mark to shoot at. The refinement of the corrective measures can then be worked out more in detail, and, after having been in effect for a reasonable length of time, ultimate standards can be set from which future work can be estimated.

This method of tentative standards is unusual in that it primarily shows the necessity for improvement by comparing what is with what should be. It also is unusual in that it works from the top down instead of from the bottom up. In other words, the output in finished product is the starting point rather than the individual parts. Knowing the required output, it is a comparatively simple matter to set standards for the parts, keeping in mind the necessity for most favorable conditions when ultimate standards are set.

As a direct result of the war, the shipbuilding industry in this country has expanded enormously, as evidenced by the fact that the number of men employed increased from 50,000 to over 350,000. The question is often asked: "What is to be the final outcome?" It is not believed possible to answer that question at the present time, though it is generally conceded that the survival of the fittest will play a most important part.

Eventually the industry will settle down to a basis regulated by the law of supply and demand, and when that time comes the weak sisters will be crowded out. In the meantime there is enough business in sight to replace tonnage lost during the war to absorb the world's output provided prices are reasonable. This state of affairs may last for two years or more, so that opportunity is at hand for the shipbuilder to put his house in order. Will he take it and be reasonably assured of survival or will he allow it to pass and fight against the inevitable and finally be compelled to acknowledge defeat?

In both Figs. 1 and 2, attention is called to the wide variations in deadweight ton costs. As similar conditions apply to many shipyards, is it not worth while for executives to give this subject the most serious consideration? Foreign competition has not yet developed its full effect, so the time to do this is now, and not after organizations are adversely affected through idle ways due to loss of business either at home or abroad.

An Analysis of the Isherwood System*

Transverse Stresses and Diagonal Distortion—Failure of Bottom Through Collapsing—Strength of Decks—Miscellaneous Stresses

BY JOHN FLODIN, M. E.

ALTHOUGH not as important as the longitudinal stresses, the transverse stresses a vessel is subjected to are often quite severe, and it is consequently essential that a change in the system of construction does not unduly weaken the vessel transversely any more than a weakening longitudinal would be permitted. For example, if data based on long experience seem to indicate that a certain bilge connection furnishes but a reasonable margin of strength, we cannot arbitrarily substitute another connection of less strength without adequately compensating for the loss. By doing so we should expose the vessel to serious straining when, especially if heavily loaded, it encounters a seaway. Immediate failure would perhaps not result, but the riveting would gradually give way, and troublesome leaks would develop.

Failures due to the three principal transverse stresses are indicated in Figs. 5 to 9, inclusive.†

DIAGONAL DISTORTION

A distortion of the hull in the manner and because of the stresses indicated in Figs. 5 and 6 would evidently mean a failure of the transverse framing in the vicinity of the bilge, at or near the connection at the second deck to the side of the ship, and possibly, but not necessarily, at or near the connection of the upper deck to the side of the ship. Considering these in the order named, first for the transverse vessel and then for the Isherwood vessel, we have:

The Bilge Connection.—From an inspection of the midship section we can conclude that the weakest point in the bilge connection is either through the riveting connecting the side frame to the bilge bracket, or through the frame itself, in line with two of the connecting rivets, as indicated by the dot-and-dash line in Fig. 10. The failure of the framing would in either case be accompanied by a failure of the shell plating, so that we should include, as contributing to the strength of the framing, a strip of the shell plating equal in width (i. e., in the longitudinal direction) to two and one-half times the width of the shell flange of the frame bar, reduced by one-half the diameter of the shell rivet in order to obtain a result that will represent a mean between tension and compression conditions.

To determine the strength of the riveted connection, the polar moment of inertia about the center of strength of the section must be found. This is most conveniently done by first finding the center of gravity of the connection and then calculating the moments of inertia about vertical and horizontal axes through the center of gravity. The sum of these two moments of inertia equals the desired value of the polar moment of inertia.

Taking the shearing strength of the rivets as equal to the tensile and compressive strength of the steel, the moment of inertia about the horizontal axis is found to be 577.5 inches^4, and about the vertical axis 157.5 inches^4, from which the polar moment of inertia equals 735 inches^4. If we regard the distance of the center of the farthest rivet from the center of gravity of the connection (or, more correctly, the center of strength) as the distance to the extreme fiber, the polar section modulus equals $735 \div 13.13 = 55.98$ inches^3.

The moment of inertia of the side frame, deducting for the rivet holes, equals 186.86 inches^4, and the section modulus equals 25.5 inches^3.

The Second Deck Connection.—Four possible modes of failure present themselves at the juncture of the second

* Concluded from the February issue.
† These sketches are borrowed from Holms' Practical Shipbuilding.

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deck beam to the frame. The beam bracket may be ruptured as shown in Fig. 5 (see also Fig. 12); the frame may fail at the toe of the bracket; the riveting of the bracket to the frame or to the beam may fail; or, finally, the beam may fail at the inboard toe of the bracket. It is very evident, however, that the bracket plate is con-

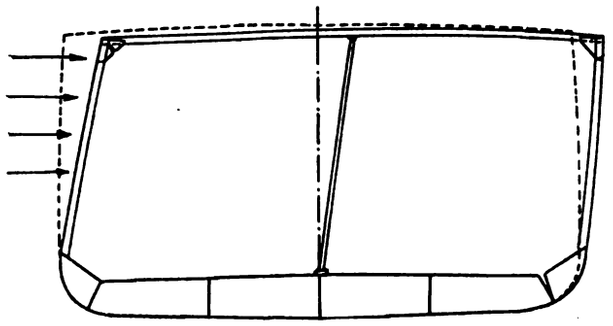

Fig. 5

siderably stronger than the rivets connecting it to the beam or to the frame, so that the first-mentioned possibility may at once be discarded. Furthermore, the section modulus of the side frame, without correcting for the riveting or for the strip of shell plating contributing to the strength of the frame, is 21.9 inches^3, as compared to the section modulus of 12.7 inches^3 for the deck beam channel, so that the possibility of failure of the side frame at the toe of the beam bracket may also be abandoned.

For the strength of the bracket riveting, considering the rivets in one arm of the bracket only, we may divide the sum of the second moments of the rivets about the center

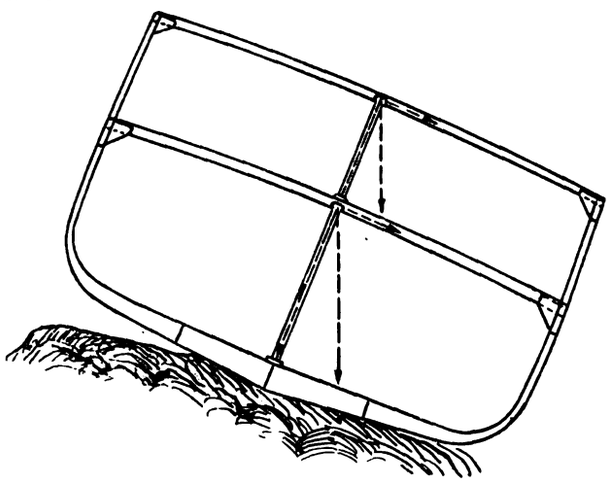

Fig. 6

of the rivet nearest the heel by the distance to the toe rivet. The section modulus thus obtained is 26.02 inches^3. Calculating the strength of the deck beam at the toe of the bracket, including again a strip of plating, we find that the section modulus is 16.1 inches^3.

The Upper Deck Connection.—Applying the same reasoning to the upper deck connection (see Fig. 13), we find the section moduli for the riveting and for the deck beam at the toe of the bracket to be 18.61 inches^3 and 13.2 inches^3 respectively.

The Combined Strength.—As a representation of the ability of the hull to resist forces tending to cause diagonal distortion, we may, then, take the sum of the least section moduli at each connection, or, excluding the upper deck, $(25.5 + 16.1) \times 2 = 83.2$ inches^3, and, including the upper deck, $83.2 + 2 \times 13.2 = 109.6$ inches^3, the factor of two being introduced by the fact that failure cannot occur at one side of the vessel alone.

The corresponding values per foot length of the vessel are 38.4 inches^3 and 50.5 inches^3, the frame spacing being 2 feet 2 inches between peak bulkheads.

Diagonal Strength of the Isherwood Ship.—The corre-

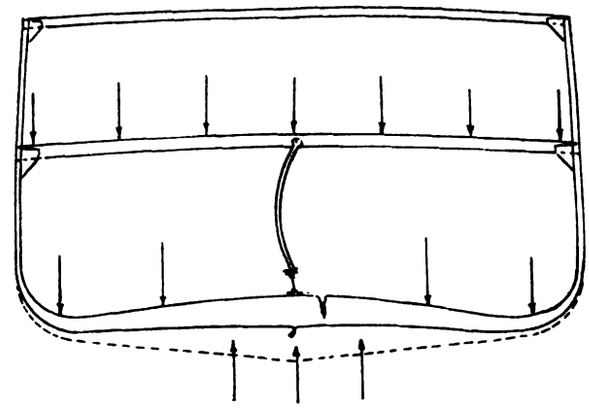

Fig. 7

sponding probable points of failure in the Isherwood vessel are:

At the bilge connection:	At longitudinal No. 14.
At the second deck:	At the second longitudinal from the side of the vessel.
At the upper deck:	At the second longitudinal from the side of the vessel.

These points of failure, while they are taken at the points of least section moduli, are somewhat further re-

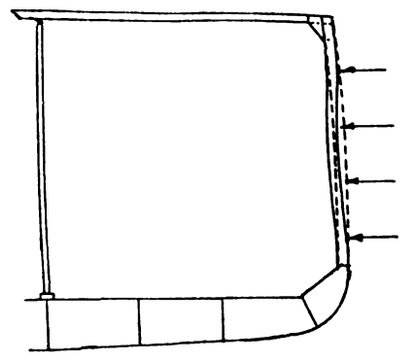

Fig. 8

moved from the theoretical points of failure than were the corresponding points in the transversely framed vessel, thus introducing the factor of a lever arm. It is impossible to express this difference mathematically, if, indeed, such an expression should be desired, and consequently the difference has been omitted in these calculations. It should be remembered, however, that this omis-

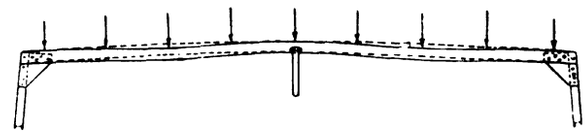

Fig. 9

sion makes the exactness of the conclusions somewhat doubtful, the doubt being in favor of the Isherwood ship.

Calculating the strength at the points indicated above, using the same reasoning as for the transversely framed vessel, but including as part of the transverse at longitudinal No. 14 a strip of the shell plating equal in width to only one and one-half times the combined width of the

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shell clip flanges, since a double angle connection is here used, we have, for the bilge connection, a section modulus of 241.0 inches³, for the second deck connection a section modulus of 41.7 inches³, or a total of 565.4 inches³ for both sides.

The modulus for the upper deck connection is 47.5 inches³, giving a total of 660.4 inches³ for both sides of the entire section. The transverse spacing being 12 feet (except in the peaks and forward of the three-fifths length), the combined section modulus per foot length of the ship becomes 47.1 inches³ excluding the upper deck. and 55 inches³ including the upper deck.

Summary.—For more ready comparison we may summarize these section moduli as follows, the values being given in inches³ for both sides of the vessel:

Connection	Transverse Framing—Per Frame Space	Transverse Framing—Per Foot of Ship	Longitudinal Framing—Per Frame Space	Longitudinal Framing—Per Foot of Ship
At the bilge.....	51.00	23.55	482.0	40.17
At the second deck.	32.20	14.85	83.4	6.95
At the upper deck.	26.40	12.20	95.0	7.92
Totals	109.60	50.60	660.4	55.04

It will be noted that the Isherwood vessel compares very favorably with the transversely framed ship as far as the total resistance to diagonal distortion is concerned. The Isherwood bilge connection develops 70.6 percent more strength than the corresponding connection in the older system of framing, while the Isherwood deck connections are weaker. And it may be argued that this is a more favorable distribution of strength, since the bilge connection is continuously subjected to severe stresses due to the water head. There is unquestionably some justification for this viewpoint, provided that the deck connections are not weakened to such an extent as to make the decks themselves unsafe. This question will, however. be considered separately under the head of "Strength of Decks."

FAILURE OF BOTTOM OF SHIP THROUGH COLLAPSING

In the case of a failure of the type shown by Fig. 7, which might occur when the weight of the vessel is resting on keel blocks along the centerline, or on the ground, as in the case of stranding, a considerable discrepancy exists between the transversely and longitudinally framed vessels. In the former we have two rows of pillars, giving a transverse span of 21 feet between the pillars, while in the latter case there is but a single row of pillars along the centerline of the vessel. In the former vessel the stressing of the bottom to failure through collapsing would then mean the failure of the floors at or near the centerline, while in the latter the most dangerous point of loading would be at some point about halfway between the centerline and the support at the margin, and the failure would then occur near the point of loading.

For the transversely framed vessel we find the section modulus to be 243.8 inches³ for the floor connection at the centerline (the line of fracture is supposed to pass through the riveting of the floor clips to the center vertical keel, past the top and bottom horizontal keel angles, and through the flat keel and rider plates) and 283.3 inches³ for the floor through the first lightening hole from the centerline of the ship. In each case a strip of the shell plating equal to two and one-half times the horizontal flange of the connecting angle is included, and also a strip of the tank top plating of similar width less one rivet diameter, the tank top plating being in tension, while the shell plating is in compression.

The least section modulus is, then, 112.2 inches³ per foot length of the ship. Regarding the floor as an encastre beam* and taking the allowable fiber stress as 16,000 pounds per square inch, we may find the safe concentrated load by the formula:

$$M = \frac{Pl}{8},$$

where M is the bending moment in inch-pounds, P is the load in pounds, and l is the length of the span in inches.

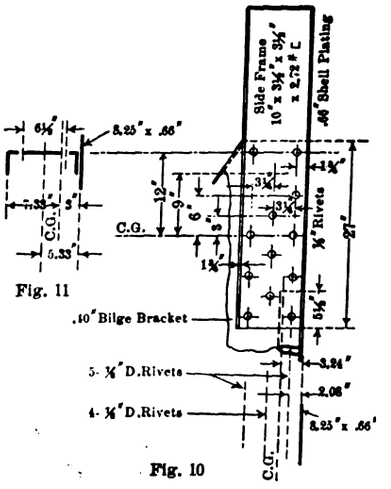

Fig. 11

Fig. 10

Figs. 10 and 11

Equating this to the resisting moment, we have:

$$P = \frac{16{,}000 \times 112.2 \times 8}{20 \times 12} = 57{,}000 \text{ pounds per foot of ship.}$$

The area of a floor section through a lightening hole near the pillar is 22.69 square inches, or about 10.5 square inches per foot of ship, giving a maximum shearing stress of ½ × 57,000/10.5, or about 3,000 pounds per square inch.

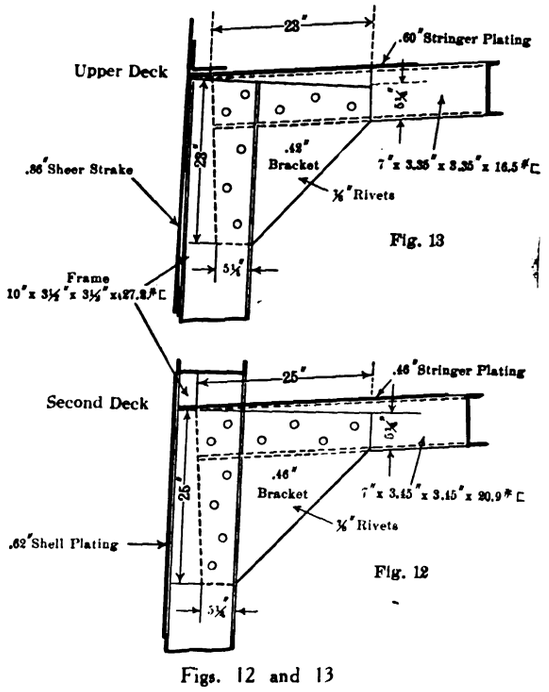

Fig. 13

Fig. 12

Figs. 12 and 13

* It would be more reasonable to consider the floor a continuous beam, the assumption here made not being strictly correct; but, since this error of conception will be used for the Isherwood ship also, the final result will be a very close approximation to the true relation in the strength of the two vessels.

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In the Isherwood ship the failure would undoubtedly occur through a lightening hole, the line of fracture passing through the notches for both the tank top and bottom shell longitudinals. The modulus for this section is 303.2 inches^3 for each transverse floor and for the intermediate floors, or 50.5 inches^3 per foot of ship.

Regarding the floor again as an encastre beam, whose span in this case is 20 feet (allowing a reasonable overlap with the side transverse bracket), we have:

$$P = \frac{16{,}000 \times 50.5 \times 8}{20 \times 12} = 26{,}900 \text{ pounds per foot of ship.}$$

It will be seen that the strength of the Isherwood ship falls far short of the strength of the transversely framed

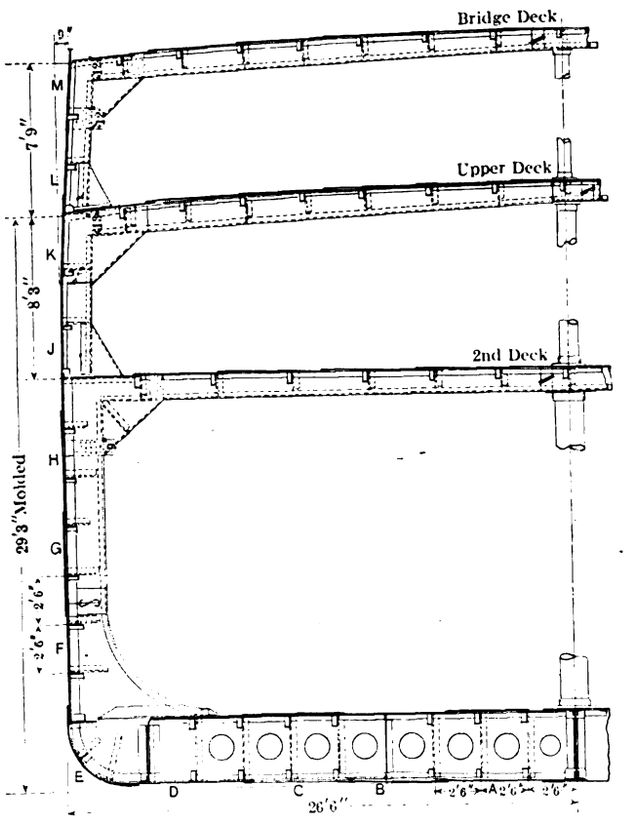

Fig. 14.—Midship Section of Isherwood Framed Ship

one as far as the collapsing of the bottom is concerned. It should be noted, however, that the centerline arrangement of the pillars in the Isherwood ship gives that ship an advantage when resting on keel blocks. But this pillar arrangement is not a characteristic of Isherwood ships in general, since many of them have two rows of pillars, and would then show a weakness as compared with the transverse construction that is roughly represented by the results obtained above. In either case this strength represents resistance against extraordinary external forces and is not to be regarded as representing conditions met with in ordinary service. The stress on the bottom of the ship, using the load draft of 23 feet 6 inches, but not making any allowance for the balancing effect of the cargo, would set up a fiber stress of about 5,800 pounds per square inch in the floor of the Isherwood ship, showing that for sea conditions the Isherwood construction furnishes a large margin of strength.

It should further be remarked that Lloyd's rules permit the omission, in transversely framed vessels, of alternate floor plates, except forward of the three-fifths length and under the engines and boilers, at which parts Isherwood vessels have additional floors. In cases where alternate floor plates are omitted, only the bottom frame bars and the reverse frames are fitted, and even the reverse frames may, under certain conditions, be omitted. A vessel so constructed would show very nearly the same strength of bottom as the Isherwood vessel, namely, a maximum safe load of 28,500 pounds and 26,900 pounds for the two types respectively per foot length of ship.

In view of the above figures it may, then, be said that even though the Isherwood vessel does not possess the same strength of bottom per foot length of ship as a transversely framed vessel of the same size and type, built with floors at every frame, the strength developed by the

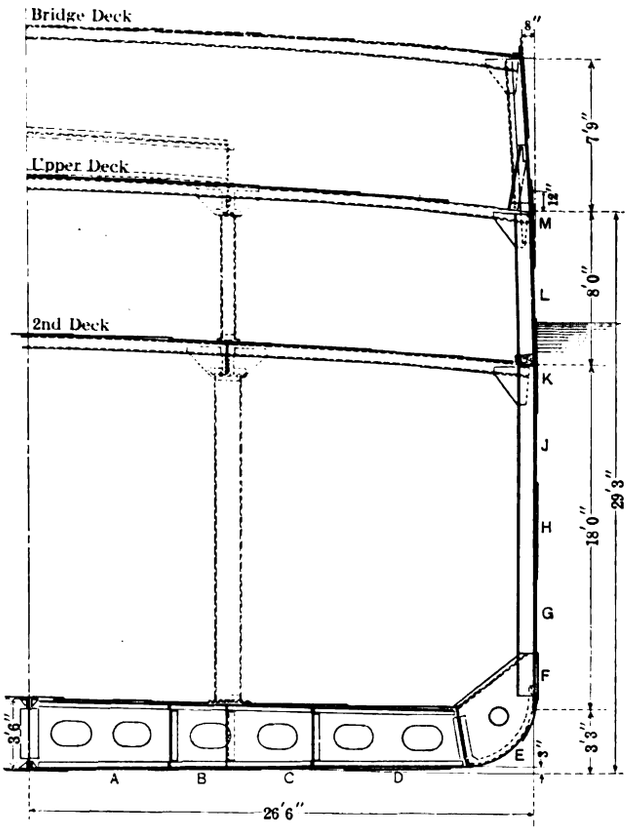

Fig. 15.—Midship Section of Transverse Framed Ship

Isherwood construction is ample, and the construction is consequently more logical.

The Shell Plating

On the midship sections (Figs. 14 and 15) the shell plating is seen to be lighter for the Isherwood vessel. The fact is, however, that the thickness of the shell plating of the Isherwood vessel is in accordance with Lloyd's rules, regardless of the change in the system of construction, while the shell plating of the transversely framed vessel was increased in thickness to compensate for the omission of the side stringers. Hence no comparison of the strength of the shells need be made, except in so far as they enter into the longitudinal strength of the ships.

Collapsing of the Side Framing

In connection with the analysis of the resistance of the two vessels to diagonal distortion, it was shown that the strength of the Isherwood transverses at longitudinal No. 14 is represented by 40.17 per foot of length of vessel, as compared to 23.55 for the strength of the side

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frame of the transversely framed vessel at the top of the bilge bracket. The Isherwood transverse at the point considered is about one inch deeper than it is at the longitudinal next above, so that the strength ratio of 70.6 percent, in favor of the Isherwood vessel, does not quite apply to the strength of the side framing. But, owing to the great excess in strength of the Isherwood transverse, we need have no hesitancy in saying that there is a considerable margin of strength of side framing in favor of the longitudinally framed ship—a margin of, perhaps, about 68 percent.

Strength of Decks

As in the case of the strength of the floors, the difference in the pillar arrangement introduces a considerable discrepancy in the deck strength of the transversely and longitudinally framed vessels. In the transversely framed vessel the strength of the decks is obviously dependent on the strength of the deck beams and on the maximum span, which is again the distance between the pillars, or 21 feet. Including, as before, a strip of the deck plating as contributing to the strength of the beam, the section moduli of the deck beams are found to be 12.61 inches^3 for the upper and 15.2 inches^3 for the second deck beam, or, per foot of ship, 5.81 inches^3 and 7.01 inches^3, respectively. Using a fiber stress of 16,000 pounds per square inch and applying the formula for uniformly loaded encastre beams, the upper deck beams are found capable of supporting 8,860 pounds per foot length of ship, or 423 pounds per square foot of deck area (a rather high value, since it corresponds to a 6.75-foot head of water—more than twice the height of the bulwarks—or a 10-foot deck load of lumber), while the safe load for the second deck is 10,700 pounds per foot length of ship, or about 510 pounds per square foot of deck area (again a rather excessive value, since it would allow the carrying of a homogeneus cargo weighing 64.5 pounds per cubic foot, a figure considerably above what the buoyancy of the vessel could support).

It will be noted that the weakest part of the decks of the transversely framed vessel is between the pillars, that is, between the hatches. In the Isherwood ship the load on the decks between the hatches is supported by the deck longitudinals, from which the stresses are transmitted to the bulkhead at the middle of the longitudinal span between the hatches and to the hatch end transverses at the ends of that span. Calculations similar to those made for the decks of the transversely framed vessel show that the deck longitudinals are capable of supporting loads of 2,290 pounds and 3,310 pounds per foot length for the upper and second decks respectively. Because of the variations in the spacing of the longitudinals, this means that the maximum safe load for the upper deck is 665 pounds per square foot between the hatches and 723 pounds per square foot between the hatch-end transverses outboard of the fore-and-aft hatch coamings, while the second deck could carry a load of 945 pounds per square foot between hatches and 830 pounds per square foot in the wings.

This, however, does not take care of the strength of the decks at the wings along the sides of the hatches. Here the loads on the longitudinals are transmitted to the half-transverses that furnish the intermediate reactions. These half-transverses have section moduli of 36.55 inches^3 and 34.3 inches^3 for the upper and second decks respectively. Assuming that the decks are uniformly loaded up to the smaller maximum capacity found above for the space between the hatch-end transverses, and that the load is concentrated at the points of support of the longitudinals, we can proceed to determine the fiber stresses. In either deck the extreme outboard longitudinal is directly supported by the transverse deck bracket, so that the loads borne by that longitudinal and directly by the shell connection do not add to the bending moment. For the rest of the transverse beam the bending moments are approximately 500,000 and 520,000 inch-pounds, giving fiber stresses of 13,600 and 15,200 pounds per square inch in the upper and second deck half-transverses respectively.

The inboard ends of these half-transverses are supported by the fore-and-aft hatch coamings, which in the Isherwood ship are somewhat stronger than in the transverse vessel. The reactions of the fore-and-aft hatch coamings are in turn borne by the hatch end transverses, which also receive the actions from the ends of the longitudinals between hatches and outboard of the fore-and-aft coamings, the last loads being similar to those borne by the half transverses. These hatch-end transverses are heavily built and are reinforced by a 10-inch by 1.0-inch face plate for the second deck, and a 10-inch by 0.70-inch face plate for the upper deck, although these are not shown on the midship section (Fig. 15). The loads are heavy, however, and the fiber stress at either deck is somewhat in excess of 40,000 pounds per square inch. Since the bending moment, and hence the fiber stress, are diectly proportional to the loads, we may conclude that the safe loads found above are about two and one-half times too great. The deck loads for the Isherwood vessel should, then, be about 280 pounds per square foot for the upper deck and 330 pounds per square foot for the second deck, as compared to the corresponding values for the transversely framed vessel of 423 pounds and 510 pounds per square foot.

Apparently, then, there is a loss in the strength of the decks amounting to nearly 34 percent for the upper deck and 35 percent for the second deck.

It was pointed out, in connection with the strength of the decks of the transversely framed vessel, that a large margin of strength existed. Some reduction could consequently be approved of, but it seems that it would be more advisable to increase the strength of the hatch-end transverses and reduce the surplus strength of the deck longitudinals, especially so since the fiber stresses due to longitudinal bending of the ship as a unit are unduly small.

This is, however, a question pertaining to the particular design under consideration rather than to the principles of the Isherwood system of construction.

Miscellaneous Stresses

Torsion.—The question of torsional strength would probably have escaped attention had it not been for the fact that the inquiries, which will be referred to later, elicited the information from a European shipping firm, who request that their name be not used in connection with the statements they make, to the effect that the two Isherwood ships they own and operate showed a torsional weakness. To quote their letter in free translation: "The ships seemed to be looser, allowing an undue amount of twisting. This made it necessary to stiffen them by means of additional bracketing, which successfully overcame the difficulty, but which also partly wiped out the saving of weight above referred to. But, as already mentioned, these were some of the first longitudinally framed ships ever built, and we understand that the later vessels of this kind are proving very satisfactory. * * *"

Since the torsional strength of any body is proportional to the polar section modulus, and since it is evident that the increased number and areas of the longitudinal members in the Isherwood ship mean an increase in the polar section modulus (cf. the section moduli for horizontal axes), it is rather difficult to understand how an Isherwood

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ship can allow "an undue amount of twisting." The only explanation that presents itself is that the shell and deck longitudinals were not properly connected where they were cut at the watertight bulkheads, a suggestion that appears to be a probability when it is remembered that additional bracketing successfully overcame the difficulty. But even if the bracketing were originally faulty, the shell and deck plating should have remained intact, giving these vessels practically the same polar section modulus as they would have had if they had been built to the transverse system, and they should consequently not have shown any torsional weakness.

It is not impossible, however, that the question of torsion is not fully understood; it may be that the transverse stiffening of a hollow body has an effect on the torsional strength that is not represented in the polar section modulus, but it seems probable that this effect, if it does exist, would be slight. It appears, then, very unlikely that a properly designed and constructed Isherwood ship should be weaker in torsion than a transversely framed vessel of the same type and dimensions.

Stresses Due to Vibration.—It is contended, and is probably true, that vibration is less in Isherwood ships than in transversely framed ships. But it should be remembered that the question of vibration becomes serious only when there is synchronism between the vibration period of the hull, the vibration period of the machinery, or the vibration period of liquids in tanks or liquid cargo, or between all three periods. Enough work has not been done in this field to make it possible to predetermine any one of these three vibration periods, except in so far as reciprocating machinery may be regarded to be likely to vibrate in synchronism with the period of the stroke, and it consequently seems decidedly advantageous to reduce the amplitude of the vibrations wherever that is possible.

PRACTICAL CONSIDERATIONS AND OPINIONS OF SHIPBUILDERS AND SHIPOWNERS

Among the advantages claimed by the Isherwood supporters are that the ships built to this system are more easily cleaned and repaired, and that the ventilation is improved.

It is unquestionably true that the Isherwood ships are more easily cleaned and painted, especially so in the double bottom. With the floors spaced 24 to 30 inches apart, as is usually the case in transversely framed ships, the cleaning and painting of the spaces between the floors become both an expensive and unpleasant task, whereas with the floors spaced from 5 to 6 feet apart, as is the practice in Isherwood ships abaft the three-fifths length, there is ample space and better air for the men to work in.

It is not so easy, however, to draw a conclusion as to the ease of repairing the vessel. This is a point on which the results of years of experience alone can throw light. This is also true of the question of ventilation.

In order to obtain information on these points, as well as general expressions of opinions and criticisms, inquiries were sent out both to shipowners who were or had been operating Isherwood ships and to shipbuilders who had had extensive experience in this field of work. In all, forty-eight letters of inquiry were sent out, the field covered including, besides American firms, several European countries, Australia and China. The results were, unfortunately, not very satisfactory. Many of the inquiries, or the letters sent in answer to them, were perhaps lost or miscarried because of the war-time irregularities in the mail service; and of the relatively few answers that were received, a considerable number were non-committal, or the writer had the impression that the Isherwood system had certain advantages, but admitted that he did not know this from his own experience. With but one exception, all the answers received were favorable to the Isherwood system.

The answers received from the naval architects connected with shipbuilding firms were uniformly in favor of the Isherwood system of construction, but it is not impossible that this favorable opinion was to some extent due to the greater ease and economy of fabrication and erection of the Isherwood ship.

The longitudinally framed vessel contains more bracket and small fitting work than the transversely framed one, but this item is more than offset by the lesser amount of furnacing of shapes. In erecting, the Isherwood ship offers two distinct advantages that tend to increase both the speed and economy of construction. One of these has already been mentioned in connection with cleaning and painting, namely, the greater accessibility to the various parts of the vessel, an item that seems even more important in erecting than in cleaning the ship. The second advantage is that the Isherwood ship can be erected in stories, as it were. That is to say, after the inner bottom has been completed, the side transverses up to the lowest deck may be erected, together with the transverses for that deck. All the material then taken on board, such as the deck longitudinals and plating, need be hoisted only high enough to clear the deck reached, not, as is the case with transversely framed vessels, high enough to clear the tops of the side frames, which, for the lowest deck, may mean a difference in the hoist of from 8 to 32—or more—feet, depending on the number of decks. This holds true for all decks except the highest one, although the height of the unnecessary hoist is, of course, reduced as the higher decks are reached.

To show what this apparently small item means to the shipbuilder, let us give a moment's thought to, let us say, a passenger ship of 20,000 tons displacement having four complete decks, the deck height being 8 feet in each case. This means a total height of 24 feet from the lowest to the highest deck, or an average hoist of 12 feet above the lowest deck level for all material for that deck and for the decks above. A total weight of perhaps about 1,000 tons would, then, have to be hoisted to an average greater height of 12 feet for the transversely framed vessel than would be necessary for the Isherwood ship, a difference of 12,000 foot-tons.

CONCLUSION

While the particular ship here used for purposes of analysis and comparison is not above criticism, it should be evident from the above that the Isherwood system of longitudinal framing offers many and important advantages, while the disadvantages seem to be relatively slight. Whether further development in shipbuilding will be along the lines of longitudinal or transverse framing, or a compromise between the two, is a question that the future alone can answer.

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Wooden Sectional Floating Dry Docks

General Considerations Governing Choice of Commercial Dry Dock—Location and Cost—Design, Construction and Operation

BY CARL E. PETERSEN

At the present time there are a very large number of wood sectional floating dry docks in use and under construction. It is the purpose of these notes to discuss some of the reasons for the adoption of this type as the most suitable from a commercial viewpoint.

Cost

The first consideration in the choice of a commercial dry dock is the first cost and the interest on the investment. Generally the first cost of a wooden sectional floating dock is less than that of the steel floating dock and the timber or concrete graving dock. In any comparison of costs of the various types, the cost of the dredging and mooring facilities required for the floating dock should be checked against the total cost of the other types.

A small concern commencing in business can first construct a sectional floating dock of a few sections and later increase the number of sections as the business warrants, provided, of course, that those first constructed are so designed as to take care of the expansion. This is a very desirable feature for those concerns which do not have sufficient capital to invest in a large dock. The returns from the investment can then be used to increase the size of the dock.

Another good feature of the floating dry dock is its mobility. Should business become bad at its present location it can be moved to another part of the port or to another port entirely. Also, a concern can more readily realize money on a dock of this type than on a graving dock.

Location

The proper location for any type of dry dock should be determined only after the most careful study of those factors which are necessary for commercial success. A poor location will greatly increase the cost of operation, although the dock itself may be well designed and constructed.

The principal factors to be considered in locating a dry dock are:

1. The proximity to manufacturing centers.
2. The proximity to terminal facilities.
3. The tide variation.
4. The currents.
5. The available depth of water.
6. The nature of the bottom.
7. The climate.

The proximity to manufacturing centers will influence the cost of those articles of manufacture which are needed in the repair of vessels, while the proximity to terminal facilities will determine the cost and time of shifting vessels to and from the dry dock and will also have a direct bearing on the shipment of ship material. It follows that a dry dock should be in close proximity to manufacturing and terminal facilities.

Generally efficient operation requires a small tide variation. If a floating dock is so designed that the available depth over the sill at low tides is such that it can dock a vessel equal to its capacity, there is no advantage in a large tide variation. The tide-variation is also a factor in the choice of the type of dry dock most suitable.

A floating dry dock should be so situated as to be well clear of currents, if vessels are to enter and leave it with safety and ease. The best arrangement is to have the dock located inshore between two piers, the length of which should be approximately twice the overall length of the largest vessel that can be accommodated. When so arranged, while one vessel is on the dry dock the one next in turn is placed in the slip. The advantage of this is that the time of undocking one vessel and docking another is reduced to a minimum. The sides of the piers next to and in way of the dry docks should be sheathed with wood or steel piling to prevent silting, thus reducing the frequency of dredging under the dock to a minimum.

The depth of water available is a factor in the choice of the type of dock most suitable. Where the water is shallow, a graving dock would be more favorable. On the other hand, where deep water is available close to the shore, the choice would undoubtedly be for the floating dry dock.

Design and Construction

The basis for determining the dimensions of a sectional floating dry dock is the size and weight of the largest vessel intended to be docked. In other words, each section of the dock should have a lifting capacity at least equal to the weight of that portion of the vessel which is borne by the section. The members of the sections are largely determined empirically and from good practice.

Only first quality timber, well seasoned, should be used in the construction, and, as is the case with wooden ships, care should be taken to secure the best of fastenings. The extra expense of having only the best materials and workmanship is compensated with additional years of usefulness.

The pumps used should be of the vertical centrifugal type designed to operate efficiently under a variable head. They should be located low in the pontoons and be direct-connected by vertical shafting to electric motors situated on the decks of the wings. The motors should be connected to and operated from a central control station ashore. In these modern times there is no excuse for the inefficient steam-driven reciprocating pumps, so much used in the earlier dry docks. A small centrifugal pump, also electrically driven, should be provided in each side of each section for ordinary drainage, as it usually is uneconomical to operate the main pumps for this purpose.

The ordinary sectional dock was evolved in order to permit of self-docking; that is, the length of the sections is such that when any section is disconnected and turned at right angles it can be docked by another section. However, in designing, care should be taken to have a sufficient width between the wings at the keel block level, so that when a section is docked there will be ample clearance for workmen to effect any repairs necessary. In some of the docks built this clearance is so small that it is questionable if repairs could be made.

Operation

The time of construction of a wooden sectional floating dock is usually less than that required for other types. In fact, a floating dock may be built anywhere, and, if necessary, the sections may be built in different places.

The advantages of the sectional floating dock for

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economical operation are many. With this type of dock the cost of pumping is directly proportional to the displacement or weight of the vessel to be lifted. In the case of docking a vessel which is much smaller than the capacity of the dock, only a sufficient number of sections have to be used to accommodate it, while with a steel floating or graving dock, the whole dock must be operated. The sectional floating dock is thus more economical for docking vessels of various sizes than the other types.

As the quantity of water to be pumped is generally less in the floating dry dock, the time required for the actual lifting is considerably less than that required for removing water from a basin dock. The floating dock needs only to be lowered sufficiently to place the ship over the keel blocks, while with the basin dock the amount of water above the blocks, regardless of the draft of the vessel, must always be handled. Floating docks can lift vessels whose length exceeds that of the dock. It is generally conceded that sectional docks are more easily handled than other types.

Other Advantages

Floating docks are better able to deal with vessels having a list or an abnormal draft. The dock is on a level with the surrounding shops, which is a saving in time and labor; it has the advantage of better sanitary conditions and atmospheric surroundings, there being an abundance of light and fresh air. The paint on ships' bottoms dries more quickly and the sewage from the ship can be better taken care of than in the basin dock. The floating dock has the ability to maintain a vessel in virtually the same shape as when water-borne.

In conclusion, therefore, the writer believes that, while each type of dry dock is particularly useful for a given set of conditions and requirements, the wooden sectional floating dry dock is the commercial choice where returns on the investment is the prime consideration.

Novel Method of Launching Adopted at Puget Sound Navy Yard

Ammunition Ships and Target Rafts Built in Basin Dock and Launched Simultaneously by Flooding the Dock

BY E. R. BOUVIER*

ADVANCES in shipbuilding have not ceased. In marked contrast with the usual methods of building and launching vessels, which have been followed since shipbuilding was begun, it has remained for the Puget Sound Navy Yard to introduce in the year 1919 an entirely new type of building berth and a new method of launching ships. On December 16 there were launched at this plant the U. S. S. *Pyro* and the U. S. S. *Nitro*, each a 10,000-ton ammunition carrier for the U. S. Navy, and two Navy target rafts, each 172 feet long. The whole launching operation for the two vessels and the two rafts required a gang of but 332 men and consumed but three hours' time until the craft were in the water and tied up at their respective piers. The entire cost of the operation amounted to $2,000 (£410).

Instead of the usual method, these vessels and rafts were built in a huge shallow basin or dock, the bottom of which is below sea level and especially constructed at this Navy Yard for shipbuilding purposes. This so-called building berth, or shipbuilding dock, is 950 feet long, 130 feet wide and 30½ feet deep measured from the top of coping, which is even with the grade of the main industrial portion of the yard. The bottom of the dock is 8½ feet below low tide and 28 feet below high tide.

The basin is filled through two 14-inch sea flooding valves in the caisson gate and through one 6-foot by 6-foot flume through the concrete wall at the end of the dock. At the time of the above launching it required just 61 minutes to fill the dock to the full tide of 21 feet, which gives a depth of water of 24½ feet above the bottom of dock.

The two ammunition ships are sister ships, each of 10,000 tons displacement, 460 feet long, 60 feet beam and 39¼ feet molded depth. The christening ceremony was performed on board, the bottle being broken over the bow of the vessel from a temporary christening platform erected on the main deck at the bow. The two vessels were christened simultaneously, at a given signal. The U. S. S. Pyro was christened by Mrs. G. A. Bisset, wife of Commander G. A. Bisset, (C. C.) U. S. N., the naval constructor in charge of the building of the vessels, and the U. S. S. *Nitro* was christened by Mrs. Henry Suzzalo, wife of the president of the University of Washington.

The launching operation was similar in all respects to the ordinary undocking of a vessel from a dry dock. As soon as the dock was filled the huge steel caisson, or gate, at the dock entrance was floated and moved out clear of the entrance. The vessels were then floated out of the dock and moored at their piers.

An interesting discussion arose as to the proper moment to christen a vessel launched in this manner. Some suggested that the ceremony should take place when the water touched the keel, and others suggested that the most appropriate time would be when the vessel was just water-borne. The latter suggestion was adopted. A naval officer, stationed at the head of the dock in clear view of the flooding operations, sounded a signal with an air whistle at the moment when both vessels were afloat, which was exactly at 12:46 P. M.

That the launching was entirely without the usual spectacular effect was plainly evidenced by the peculiar questioning looks on the faces of the several thousand visitors.

Had the shipbuilding dock not been needed for the building of two other large vessels awarded to the yard, it would have been entirely practicable to have completed the vessels in the dock and hauled them out with steam up and the trial boards aboard ready to proceed to sea for the official Navy trials.

Thus in the new style of building ways all problems of ground ways, launching ways, releasing mechanisms, retarding effects, launching calculations, proper grease to use, etc., are done away with. But one serious aspect presented itself in the whole operation, namely, that once the vessels were afloat, it was necessary to be prepared to see that either the vessels be removed from the dock or that they be reseated on their blocks before the tide had fallen to such an extent that the vessels' keels would not clear the sill of the dock entrance, or the top of the keel blocks, in case reseating of the vessels should have become necessary. The top of the keel blocks is 4 feet above the bottom of the dock, and, as the draft of the heaviest vessel at the time of launching was 14 feet, and as there was 19½ feet of water above the keel blocks, there was about 6 hours' leeway, in case of accident, before reseating would have become necessary. The whole launching operation was pronounced a decided success by all.

* Assistant superintendent, Navy Yard, Puget Sound, Washington.

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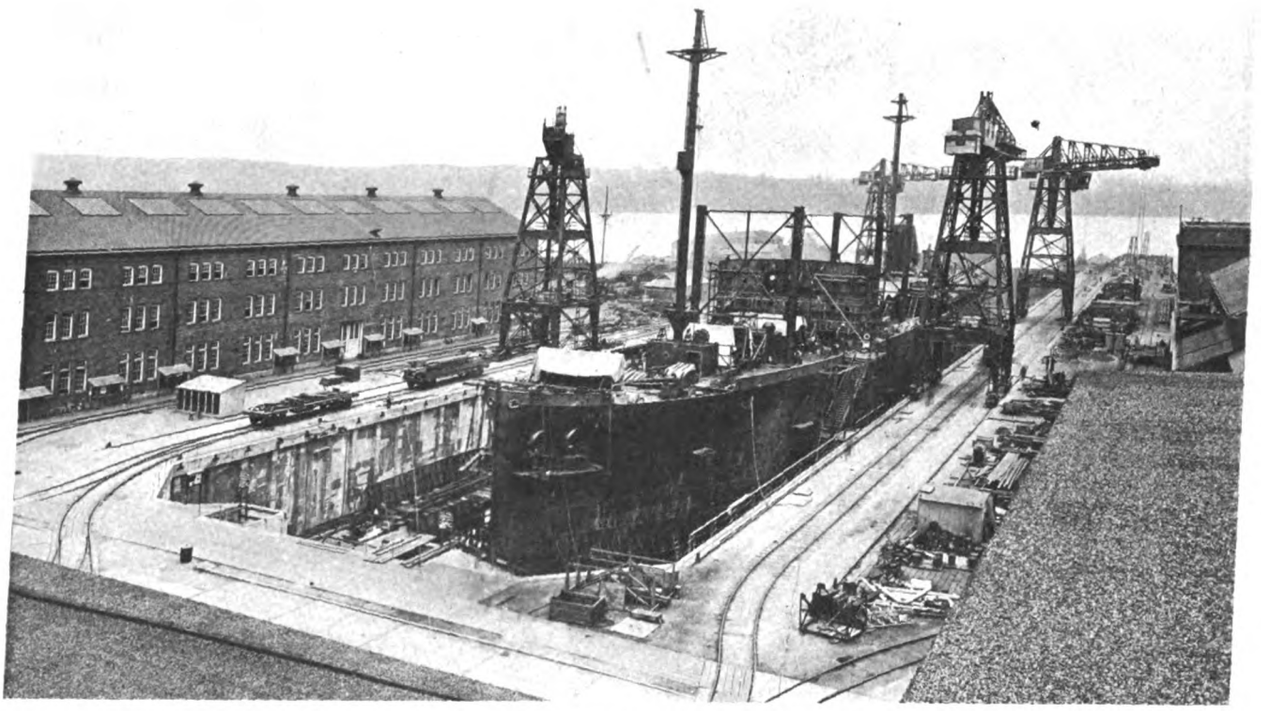

Fig. 1.—General View of Shipbuilding Dock, Showing Ammunition Ships Under Construction

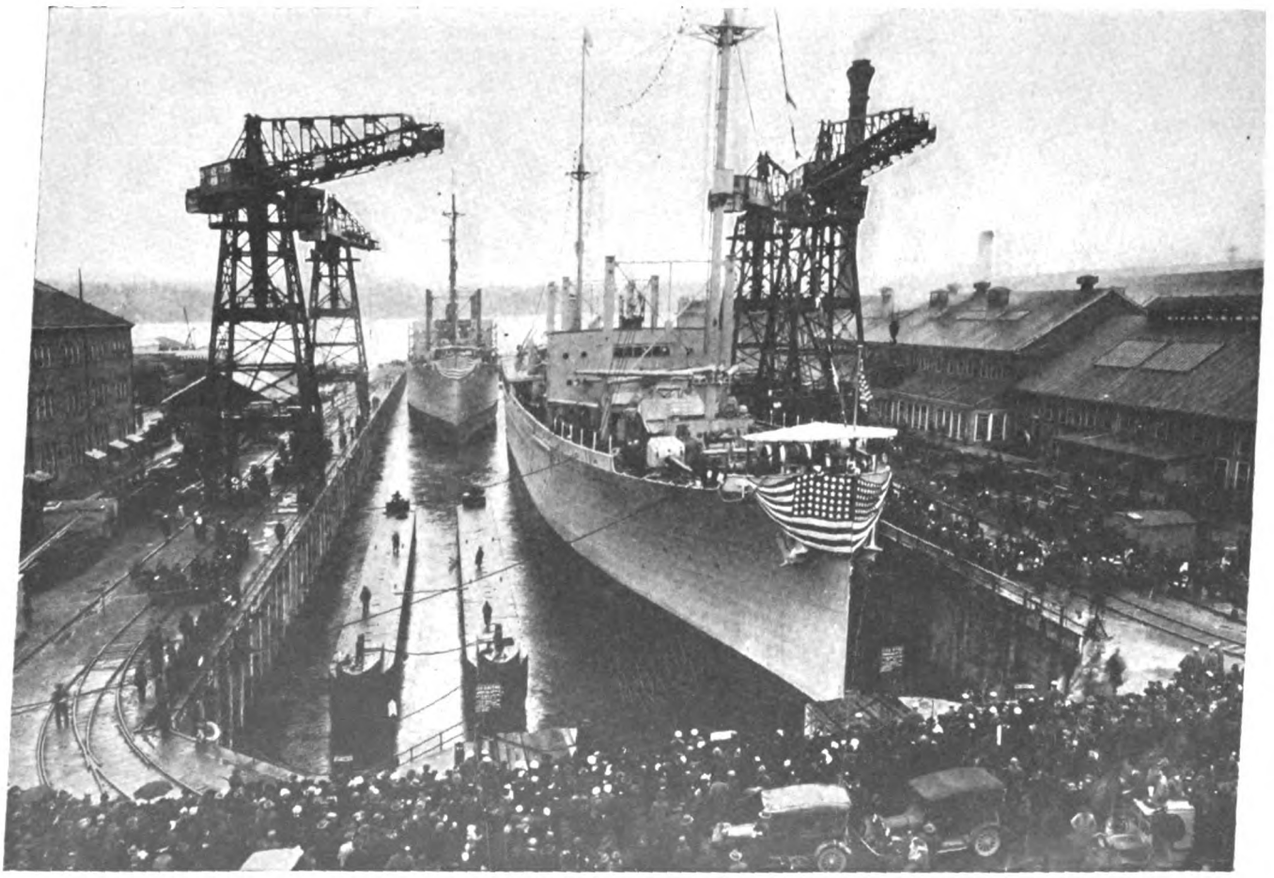

Fig. 2.—Launching Ammunition Ships *Pyro* and *Nitro* at Puget Sound Navy Yard by Flooding Basin Dock in Which They Were Built

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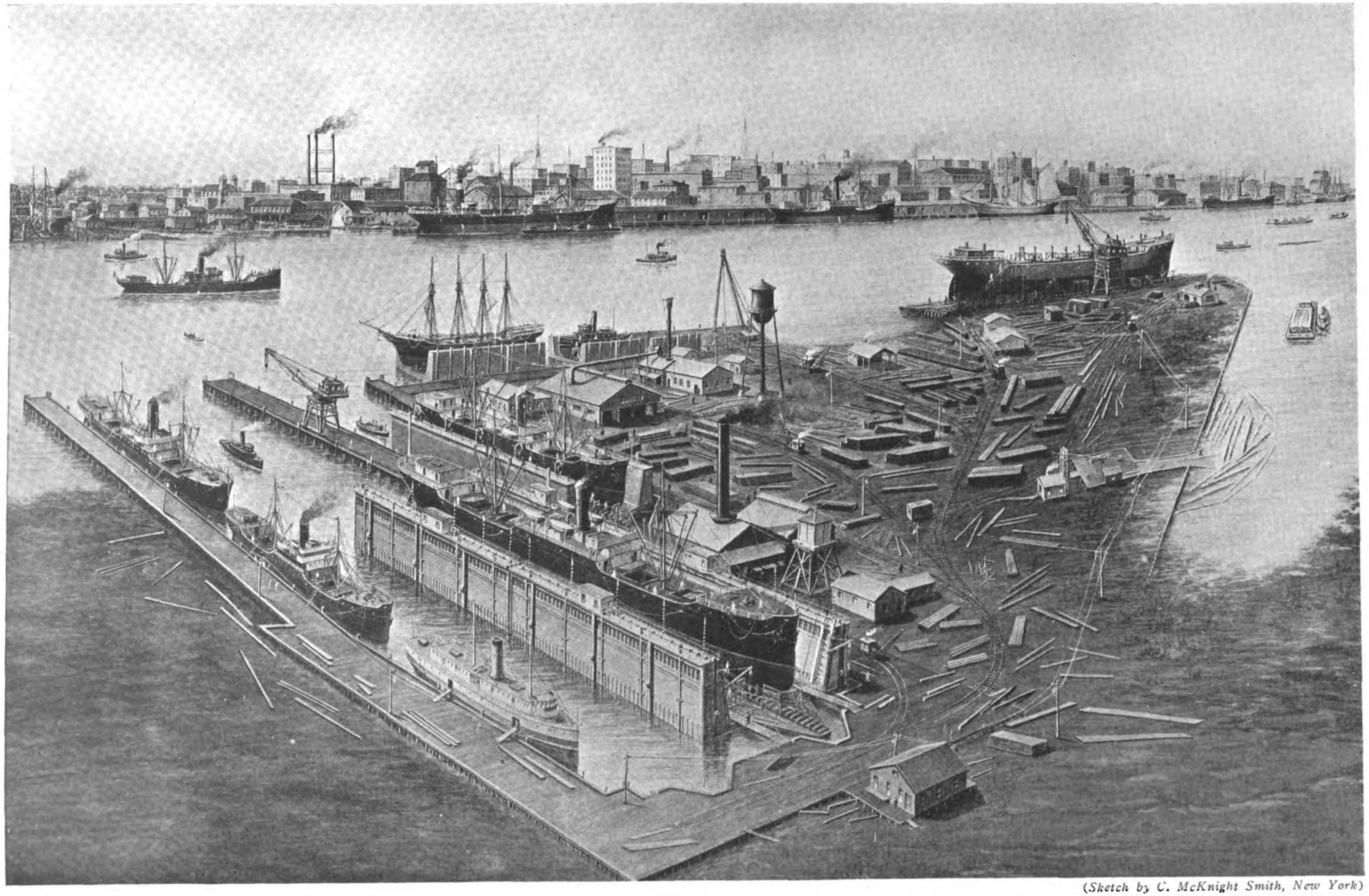

(*Sketch by C. McKnight Smith, New York*)

Fig. 1.—General View of Pinto Island Plant of Alabama Dry Dock and Shipbuilding Company, Mobile, Ala., Showing New 10,000-Ton Floating Dry Dock in Operation

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Fig. 2.—Waterfront of Busy Alabama Dry Dock Plant

New Floating Dry Dock Built at Mobile

10,000-Ton Donnelly-Type Wooden Dock Added to Pinto Island Plant of Alabama Dry Dock and Shipbuilding Company

WHEN the Alabama Dry Dock and Shipbuilding Company, Mobile, Ala., was formed in January, 1917, the plants formerly owned by Ollinger and Bruce Dry Docks Company, the Gulf Dry Dock Company, the Alabama Iron Works and the Gulf City Boiler Works were united and a large addition was made to the establishment by building a complete unit on Pinto Island for vessel repairs. As the Pinto Island plant comprises the main department of dry docking and repairs, plans were made at the outset to provide ample facilities for this class of work.

William T. Donnelly, consulting engineer, New York, was retained as consulting engineer, and at the outbreak of the war had prepared preliminary drawings for a new dry dock. The subsequent rise in prices of labor and materials caused by war conditions made it necessary to refinance the undertaking, which was brought about by an agreement with the United States Shipping Board, and resulted in the building of a 10,000-ton floating dry dock with ten pontoons, the dock to be built in two sections.

The overall dimensions of the dock are as follows: Length on keel blocks, 480 feet; length on wings, 420 feet;

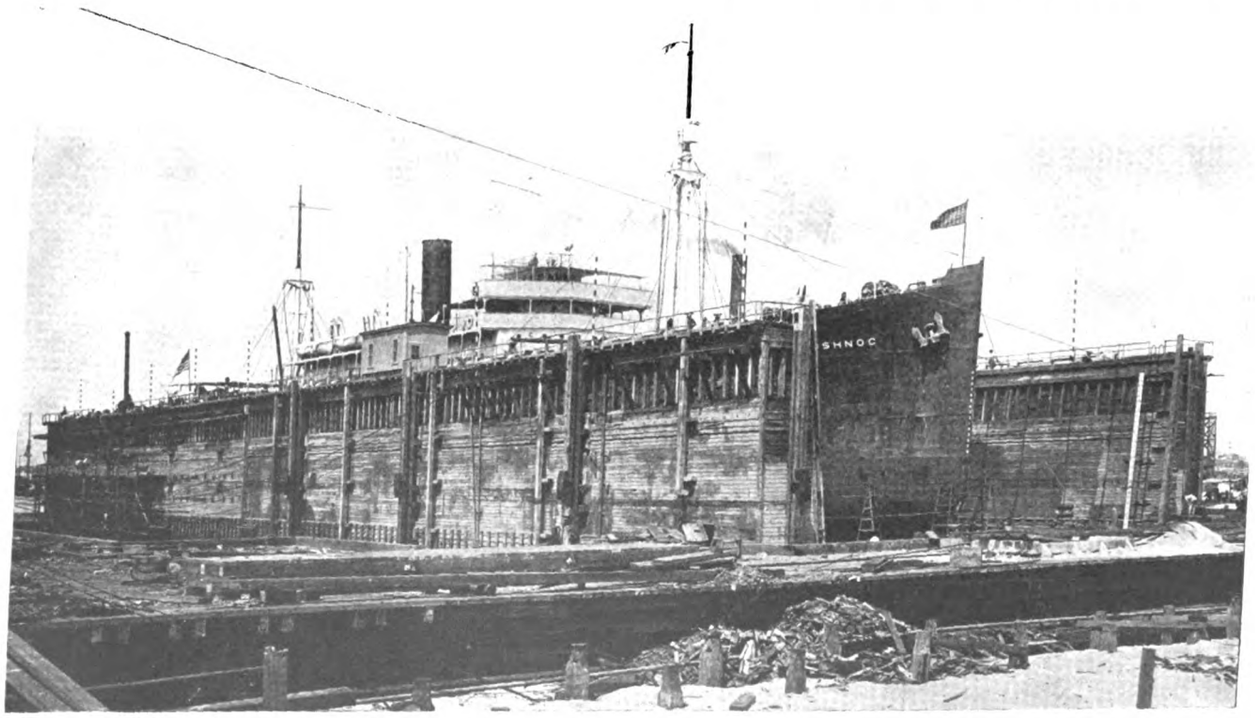

Fig. 3.—Vessel Docked in New 10,000-Ton Floating Dry Dock Before Wings of Dock Were Completed

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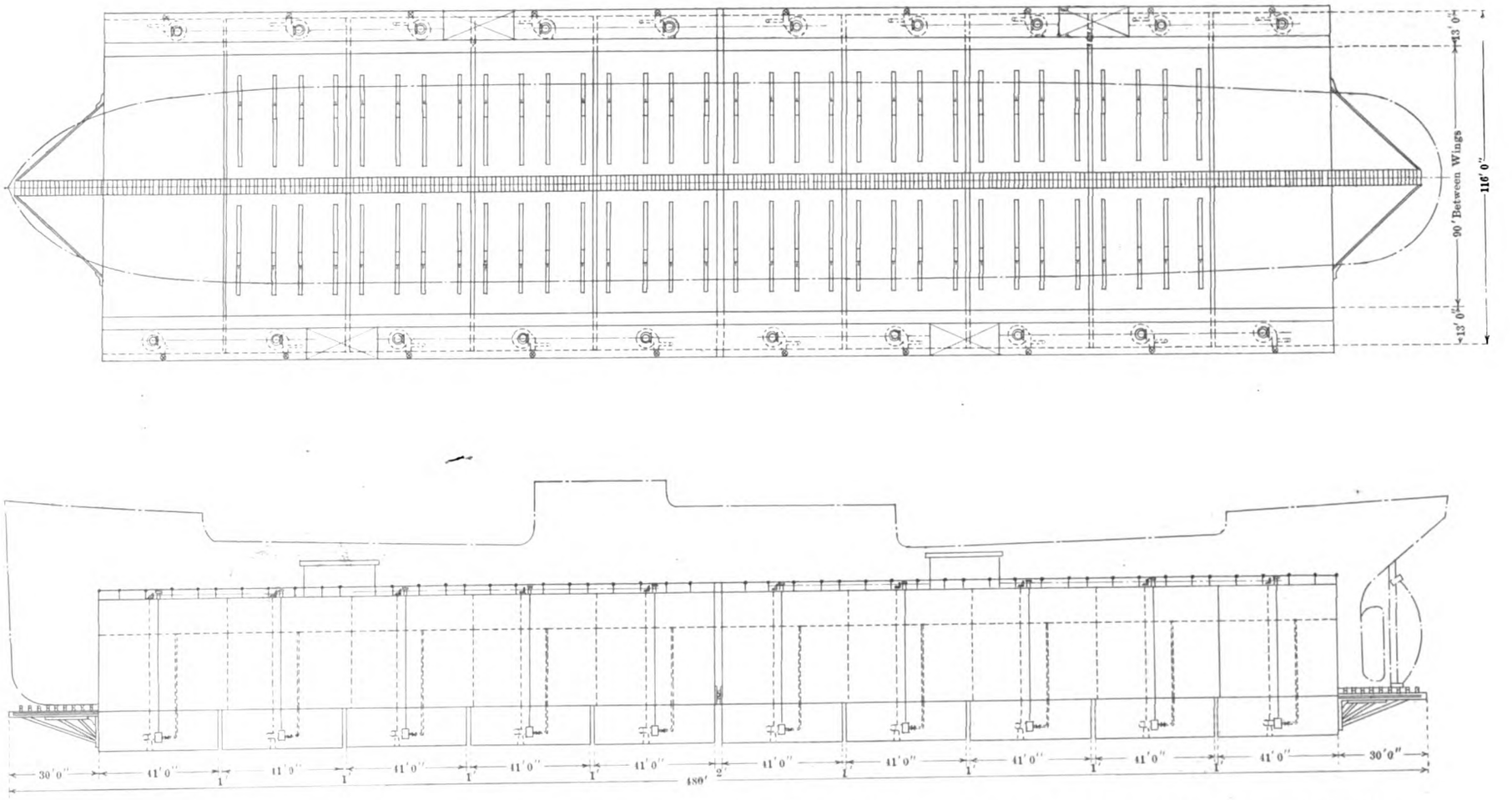

Fig. 4.—Plan and Elevation of 10,000-Ton Donnelly-Type Floating Dry Dock Built at Mobile, Showing Pumping Arrangements and Principal Dimensions

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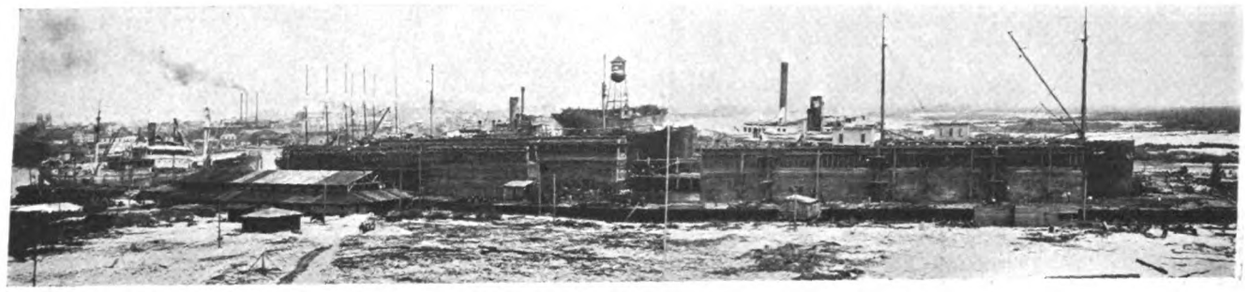

Fig. 5.—View Showing Unfinished Sections of New Dry Dock

overall width, 116 feet; width between the wings, 90 feet.

This dock was designed to take a draft of 22 feet over 3-foot 6-inch keel blocks. The pontoons were each 41 feet in width by 13 feet 3 inches deep. The wings are 13 feet wide at the bottom, 9 feet wide at the top, and 37 feet 3 inches high. Both the wings and pontoons are built of very carefully selected Southern yellow pine.

To bring about the sinking of the dock, tanks are provided in the upper part of the wings into which sufficient water is pumped to cause the dock to submerge to the desired depth. The pumping machinery is operated by electricity and consists of twenty 12-inch centrifugal pumps. Electricity is supplied for operating the motors from a local central power station.

The location of this dock in a slip required a very considerable amount of dredging and pier work. This dredging was so disposed as to raise a very considerable part of Pinto Island above the extreme Gulf level, and for the first time in the harbor of Mobile both the pier work and this area of the industrial plant was raised above the

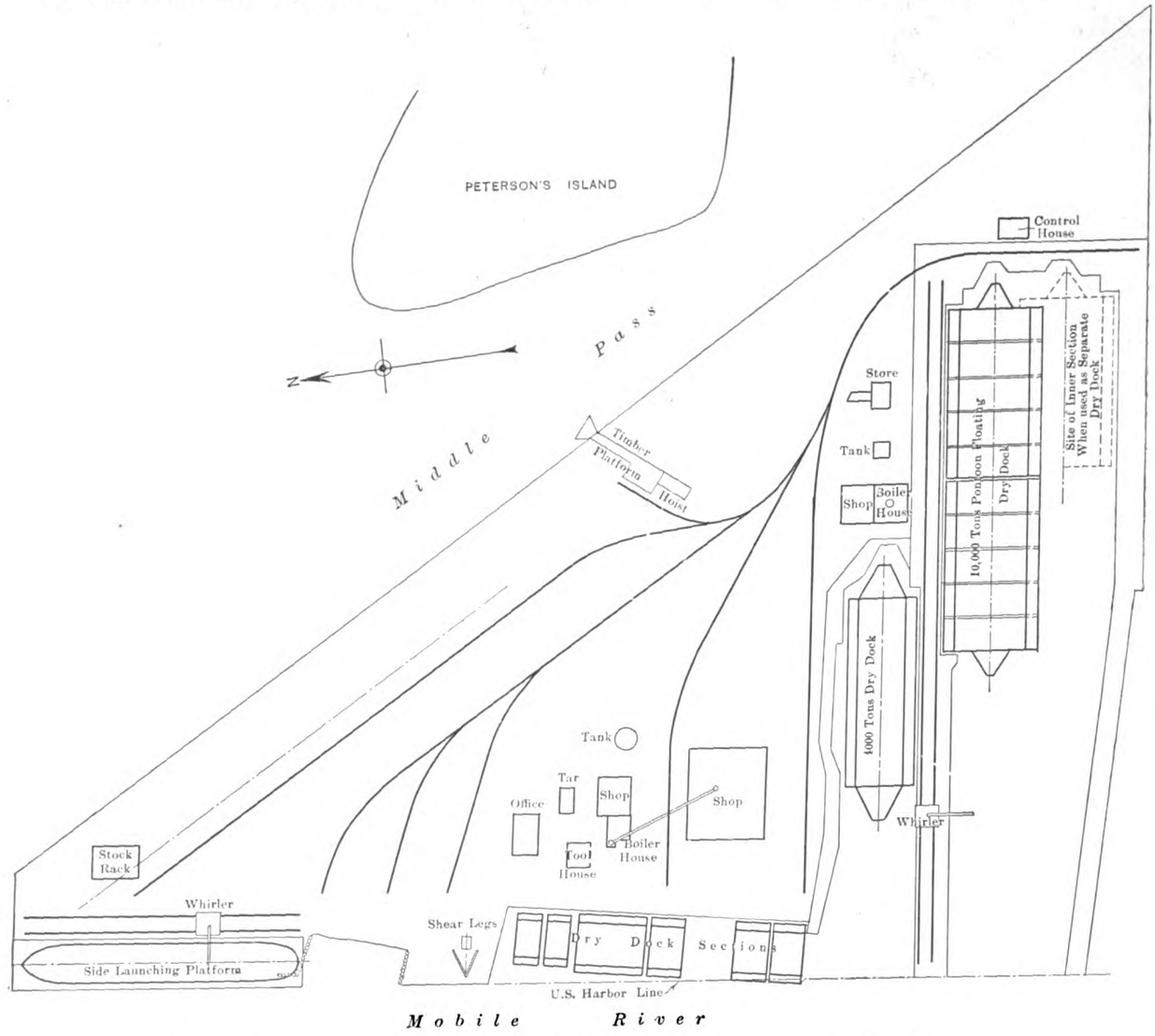

Fig. 6.—Map of Pinto Island Repair Plant of Alabama Dry Dock and Shipbuilding Company

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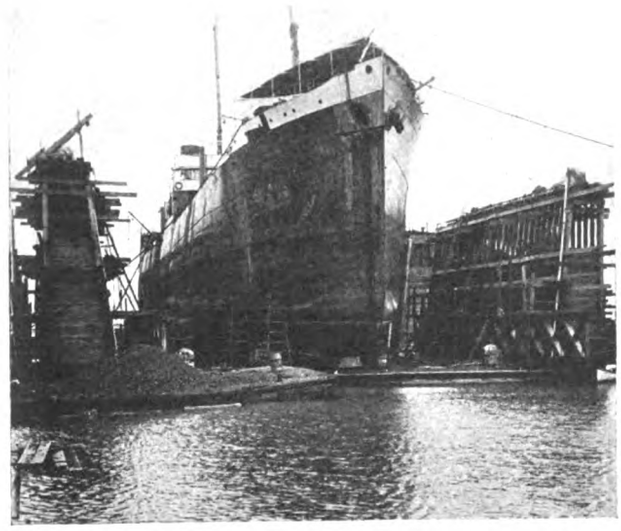

Fig. 7.—Vessel Docked in Partially Completed Dry Dock

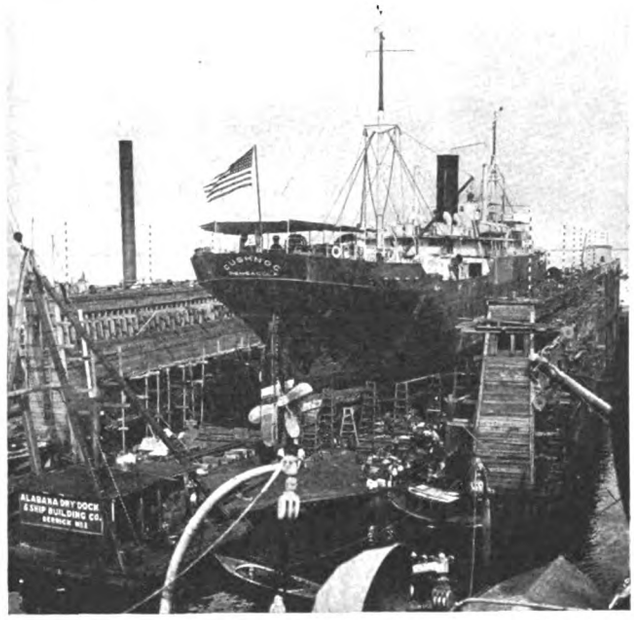

Fig. 8.—S. S. *Cushnoc* in New Dry Dock. Wings of Dock Unfinished

record level of the Gulf, due to westerly hurricanes, thus insuring the plant against interruption and loss due to storm conditions.

The first section of the dock was completed so as to dock the first vessel on May 23, 1919. This vessel, the steamship *San Antonio,* having a length of 395 feet overall and a beam of 50 feet 4 inches, was altogether too long to be docked upon this section, therefore the expedient was adopted of using two pontoons completed for the second section and erecting temporary wing structure upon them in such a manner that temporary pump connections could

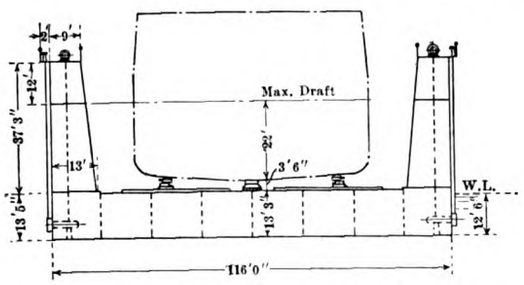

Fig. 9.—Section of 10,000-Ton Donnelly Dry Dock

be made and these two pontoons used to aid the first section in docking the vessel. This was successfully carried out and the *San Antonio* remained on the dock about seven weeks, during which time a very considerable additional amount of work was performed upon the wings of the second section. This we believe to be the first time on record when part of an uncompleted floating dry dock was used in docking a vessel without interrupting its construction.

Docking has continued with only slight interruptions of the work on the second section, and up to and including December 25, 1919, this dry dock had docked 23 vessels having a total displacement of over 100,000 gross tons. The date of completion of the dock had been agreed upon by the builders and the Shipping Board as December 31, 1919.

The pumps for this dock were furnished by the Morris Machine Works, Baldwinsville, N. Y., and the electric motors by the General Electric Company, Schenectady, N. Y. The pumps and machinery were installed by Frank Tracy, of New York. The lumber, amounting to 3,500,000 board feet, was furnished by the Mobile-Gulfport Lumber Company, of Mobile, Ala.

By reference to the general view of the plant (Fig. 1) and also the plan shown in Fig. 6, it will be seen that the Alabama Dry Dock and Shipbuilding Company has a very complete plant on Pinto Island, comprising, besides the 10,000-ton dock just described, a 4,000-ton box dock and six small sections, which can be manipulated so as to form several smaller docks. There is also a side-launching platform on the upper end of the island and a woodworking shop, office and other buildings. The machine shop of this company is now located on the Mobile side of the river, but it is planned eventually to have the whole operation concentrated upon Pinto Island.

Shipping on the Gulf is developing very rapidly and this company has its entire plant fully engaged.

Manning of American Ships

The total number of masters, officers and men required at the present time to man the registered, enrolled and licensed vessels of the United States, including 1,450 documented yachts, and aggregating in round numbers 15,325,000 gross tons, is, in round numbers, 266,000. The List of Merchant Vessels of the United States for June 30, 1919, to be issued in March by the Bureau of Navigation, Department of Commerce, shows the number of the crew (excluding master) of the 29,600 vessels and yachts included in the list. Adding the master for each vessel, the totals of the list are as follows:

Vessels	Number	Masters and Crew
Steam vessels	7,817	156,114
Motor vessels	11,525	42,941
Sail vessels	4,474	24,672
Unrigged vessels	5,853	11,425
Total	29,669	235,152

The new vessels documented since the list went to press require masters, officers and men aggregating 31,000 in round numbers, making a present total of 266,000.

Our salt-water tonnage is now nearly three-fourths of the total tonnage; but, as it includes the larger ships with relatively small crews in proportion to tonnage, the total number required to man our salt-water ships at this writing may be estimated at about 175,000.

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Senate Committee Conducts an Open Forum on Questions of Merchant Marine Policy

BY WALDON FAWCETT

FREE opportunity for expression in a wide field of discussion under the stimulus of a not unfriendly cross-examination has resulted, thus early in 1920, in the inauguration of the most ambitious open debate yet attempted on the questions at issue in the formulation of a permanent national policy with respect to the American merchant marine. The committee on commerce of the United States Senate (facing the responsibility of recommending to the upper house of Congress legislation to meet the post-war needs of American shipping and shipbuilding interests) has been conducting an open forum with an intent to bring forth first-hand evidence and expert opinion on every phase of the complex subject. Needless to say, participation in the discussion has not been limited to legislators. Rather have the senators formed an audience to which has been related the experiences and the deductions of practical men qualified to speak with authority.

Senate Committee Open-Minded

It was significant that in opening, the latter part of January, the series of hearings now in progress, Senator Wesley L. Jones, chairman of the commerce committee, stated that he had "no set views" as to how to work out the problems that are presented. Commenting on the magnitude of the task that is faced, the chairman said: "We have met to prepare legislation for the upbuilding and maintenance of an adequate American merchant marine in foreign commerce. This I consider one of the most important as well as one of the most difficult problems confronting Congress. It is important because such a marine is essential to our national defense and for our proper commercial growth and development. It is difficult because during the last fifty years but few of our people have engaged in the operation of ships and we have no established banking or commercial facilities necessary in a great shipping business.

Shipping Lines to Be Established

"We must create a system under which shipping lines will be established, commercial agencies and financial facilities created and maintained, suitable ships built and kept in operation, and our people led to think and act in terms of ships and shipping activities. This will have to be done in the face of the most determined opposition and the fiercest competition of those long established in the business and equipped by experience and the most efficient commercial and financial agencies. I think we can assume that all members of the commerce committee are agreed as to the importance and need of a merchant marine and we can well direct our attention almost entirely to the consideration of concrete means to accomplish the purpose and object desired by all." Incidentally, it was made clear that the present open forum on the subject of the merchant marine is not in any sense an investigation of the United States Shipping Board, as have been some of the hearings conducted in Washington this past year or two, but is purely a constructive parley in quest of the best legislative policy for the upbuilding of the merchant marine.

A number of men well known in shipping and shipbuilding circles have, during the past few weeks, filed statements with the commerce committee outlining their views on phases of the general mercantile marine subject that they deem of especial importance. John H. Rosseter, former director of operations of the Shipping Board, and now vice-president and general manager of the Pacific Mail Steamship Company, seeks to impress upon the framers of legislation the need of means to reduce capital cost, which he deems the most serious item in course of operation. His deduction is as follows: "I figure roughly that the 'capital cost charges' alone on a passenger vessel valued at, say, $4,000,000 (£820,000) would amount to $1,800 (£370) per day. Therefore we must find some way to permit by law to write the cost down as quickly as possible. I would venture to suggest a write-off of 10 percent for the first five years, or, better still, a sliding scale beginning, say, at 12 percent for the first two years, when good earnings can be expected, at 10 percent for the third and fourth years, and at 8 percent thereafter, until two-thirds of the cost has been recovered; otherwise the good results which are possible under prevailing conditions would be eaten up by excess profits tax, and at the end of five years our shipowners will have high book values on their hands and find it impossible to compete with other nationals with low capital cost on their ships."

Policy of the Japanese Lines

Yonejiro Ito, managing director of the Nippon Yusen Kaisha, is quoted by Mr. Rosseter as having stated in Japan that shipping men agree that in the future there will be a decline in the value of ships. Accordingly, it has been suggested to the Japanese executive that perhaps the Nippon Yusen Kaisha had better wait until such decline has materialized before undertaking the construction of 500,000 tons of ships to improve the new shipping lines which were opened by the company during the war, particularly inasmuch as not more than half of the new ships will be built in Japan, it being necessary for the Japanese corporation to look to outside shipyards for a considerable proportion of its new ships of 8,000 tons each with a speed of 20 knots. To this argument for delay in placing contracts for new ships, the significant reply of Managing Director Ito was that no ships in service anywhere are valued at a lower figure than are the vessels of the Nippon Yusen Kaisha, thanks to the policy of the company in quickly writing off cost by means of reserve funds. Finally he made the claim that even if the 500,000 tons of new ships for the Japanese lines be built at the ruling cost the company will be able to put their valuation at a low figure.

Pacific coast shipping and shipbuilding interests have been energetic in presenting at Washington pleas for the class of legislative aid that is deemed essential for the upbuilding of the industry and its continuance on the west coast. Benjamin S. Grosscup, representing the Pacific Steamship Company, while denying any intent to ask for a direct government subsidy, urged the extension of Federal aid to "keep our ships in use." His theory is that if foreign shipowners are found to have, as compared with Americans, a substantial advantage in the cost of operation, in the capitalization of a fleet or in insurance it will

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be necessary to do one of two things to sustain the American merchant marine: either there must be eliminated the obstructions to economical operation that now exist or else American shipping interests must be placed on a par with those of foreign nations by some form of compensation to meet the difference in cost of operation. His solution for the problem of the inequalities faced by American shipowners is that instead of the surplus tonnage that the Government acquired during the war being allowed to go under foreign flags, all such vessels should be sold under the restriction that they be kept under the American flag and sold at a price that will enable the purchasers to operate them.

Merchant Marine Corporation Proposed

A. F. Haines, vice-president and general manager of the Pacific Steamship Company, presented at Washington an endorsement of the plan for the organization of a Federal Merchant Marine Corporation which would take over all the vessel property and present holdings of the Emergency Fleet Corporation and which, with an assured life of at least 25 years, would be authorized to own, buy, sell, charter and build vessels, shipyards, terminals, etc. This corporation would proceed to sell the fleet now in the hands of the Government at reasonable prices for specified trades on terms of 5 percent cash and 5 percent per annum—it being the contention that the terms given would enable American shipping companies to absorb the fleet and operate the vessels. The Government would, under this plan, receive, in addition to the 5 percent per annum, 20 percent of the net earnings of the vessels, this latter being sufficient supposedly to cover the overhead of the Merchant Marine Corporation.

A considerable proportion of the expressions of opinion that have reached the commerce committee in oral or documentary form have come from attorneys and other representatives of commercial organizations, whose arguments are not, as a rule, grounded on extensive first-hand experience. Fortunately, however, the senatorial body has also had the benefit of advice from practical men. One of the latter, who spent an afternoon with the committee, was Frank C. Munson, of the Munson Steamship Company, of New York. Mr. Munson gave his personal appraisal of the current situation as follows:

Mr. Munson's Views

"It is my belief that the most vital necessity today for the benefit of the merchant marine—for the benefit of the shipbuilding industry in this country—is that a policy should be decided on and published as to what is to be the future proceeding in regard to the Shipping Board—whether it shall continue as owning the major portion of the tonnage of this country or whether it is to sell its tonnage, and if so, at what price. My belief is that the Shipping Board should sell all its tonnage within a period of six months, on a basis of $100 (20/16/8) per ton value, plus $10 (2/1/8) to $25 (5/4/2) per ton on the new and larger type boats which have been solely and entirely built since the armistice was signed, and with a depreciation of 10 percent on the $100 (20/16/8) value for vessels built or commenced to be built during the period of the war. $100 (20/16/8) to $125 (26/0/10) per ton is the basis on which England is selling its ships to her private operators, and they have an average operating cost of about 40 percent lower than ours."

In order to get before the committee concrete evidence in parallel columns, so to speak, of the relative costs of operation of American and British vessels, Mr. Munson submitted figures for the *Walter D. Munson*, an oil burner under the American flag, and the *Munarder*, a coal burner under the British flag, these vessels, of 5,800 and 5,700 tons respectively, being engaged at present in the service between New York and Cuba. The cost of operating the American vessel was given as $4,262 (£875) per month, whereas the cost for the British vessel is 723 pounds sterling, which at the prevailing rate of exchange makes the cost not much more than 50 percent of the outlay for the American vessel.

Taking as his text the fact that "the biggest single item of operating cost is the capital cost of the vessel," Mr. Munson declared that in the case of a 10,000-ton steamer, an American vessel, is, on the basis of extra capital charge, at a disadvantage of $548 (£112) per day as compared with a British vessel of equivalent capacity, whereas, as Mr. Munson expressed it, "in normal times a difference of $50 (10/8/4) a day would be enough to give all the advantage in the world to the British boats and let them take away our trade."

Munson Line in the Market for Ships

The head of the Munson company stated, in answer to the questions of senators, that his corporation is ready to buy ships, adding: "We have a reserve for that purpose, as any properly-operated American company has." His calculation was that the Munson interests would purchase not less than 25 to 30 steamers, if offered on the present basis of 25 percent payment which the Shipping Board is now allowing. The types of vessels required by this interest would be freight vessels ranging from 8,000 to 10,000 tons and passenger and freight vessels of 15,000 to 20,000 tons for express service. About half a dozen of the combined freight and passenger steamers are contemplated in the above requisition, it being the calculation to place two of these vessels in the service between New York and Cuba and four in the South American service, calling at ports in Brazil, Uruguay and Argentina.

Discussing, by suggestion of members of the committee, the situation with respect to the smaller vessels constructed for the war emergency, particularly the steamers of 4,500 tons and under, Mr. Munson gave it as his opinion that if these were offered today on the $100 (20/16/8) per ton basis (the Government absorbing its loss as a part of the war cost), "a good many of them could be sold to American owners." He predicted, however, that if disposition is delayed it will be difficult to sell any considerable proportion of them. In explanation of his skepticism, he commented: "The vessels that were started during the war and built during the war under the hurry-up process—quick riveting and hurry-up work all the way through—are very poor vessels. They have leaky rivets, trouble with their engines, and trouble with their accessories, and the result is that their repair bill is so large that you cannot operate them in competition and make any money." Incidentally, the committee's informant characterized the fabricated ships as "inferior" vessels because of the bluff bows and square stern, as well as by reason of what he designated as the "quickriveting."

The shipowner made it clear, however, that his criticism was leveled only at the vessels constructed during the war. "My opinion," he remarked, "is that the ships being constructed today and since the armistice was signed are good vessels." In testimonial to the high estimate placed by shipowners on vessels built in American yards since the armistice, Mr. Munson gave it as his belief that nearly all—certainly 75 percent of the steel vessels started since the armistice—would be absorbed within a year by private

(*Concluded on page 225.*)

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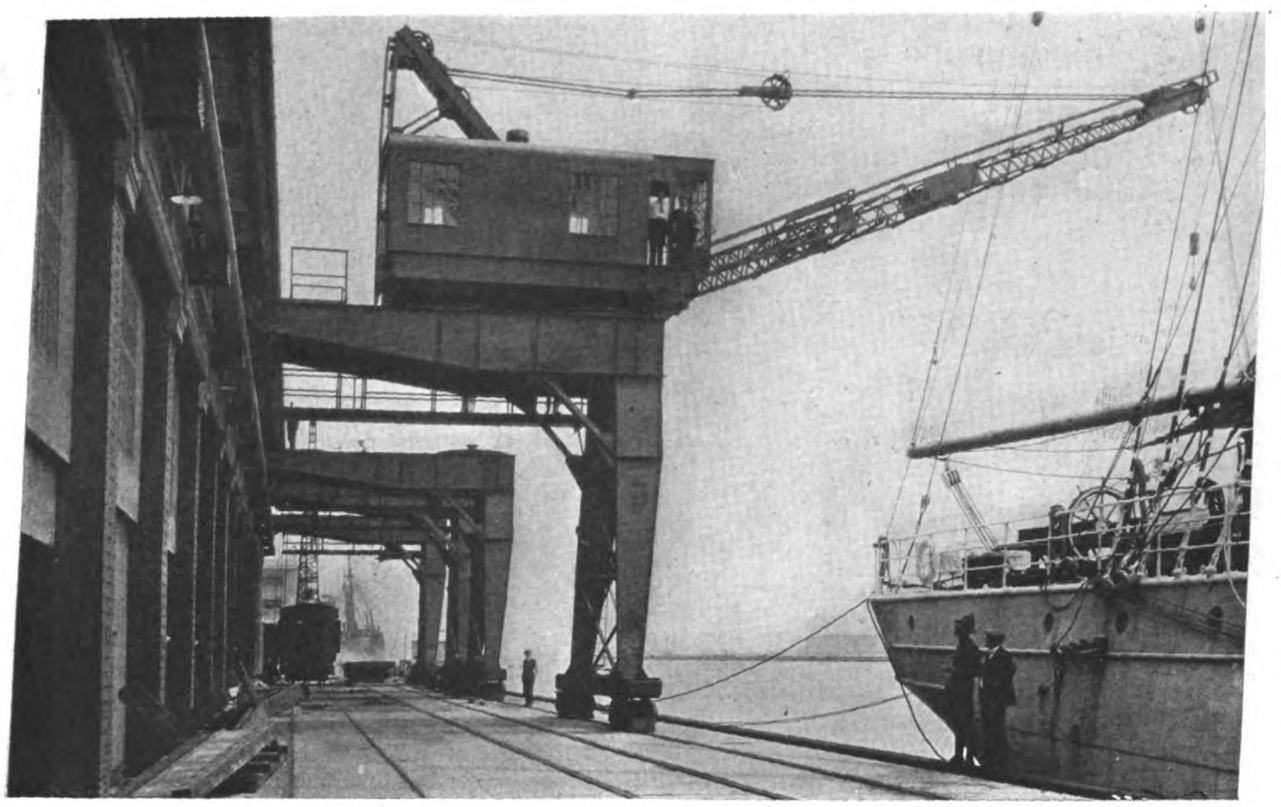

Fig. 1.—Semi-Portal Wharf Cranes Built for the United States Army Supply Base, Boston, Mass.

Bridge Cranes at the Boston Army Base

Apparatus Designed by Wellman-Seaver-Morgan to Handle 5,000- to 8,000-Pound Loads—General Electric Motor Equipment—Special Safety Devices

FOUR semi-portal bridge type hoist cranes are now being installed at the United States Army Supply Base, Boston, Mass. The first of these cranes, shown in operation in the accompany illustration, carries a lifting boom operated from a carriage, which in turn is mounted on a semi-portal bridge and arranged to rotate about a fixed axis.

The crane has four distinct motions: bridge travel along the wharf; trolley slewing; boom hoisting or luffing; and load hoisting. All of these motions are under the control of the operator located in the cab on the rotating carriage. Another drum can be added and a two-rope grab bucket operated.

Capacity of the Crane

The crane is rated to handle 8,000 pounds at a distance of 29 feet from the face of the capsill at the rate of 200 feet per minute, and 5,000 pounds at a distance of 52 feet at 250 feet per minute. It will, however, take care of occasional loads of 8,000 pounds at 52 feet from the center of rotation without undue stress in any part of the crane. These cranes, designed and installed by Wellman-Seaver-Morgan Company, East 70th street and Central avenue, Cleveland, O., have a horizontal span of 26 feet 5 inches; the maximum reach of the boom from face to capsill is 44 feet, the minimum radius of the boom, 29 feet.

The angle through which the boom may be slewed equals 360 degrees. The boom may be hoisted or luffed at the rate of 125 feet per minute. Two rotations of the trolley per minute are possible with 5,000 pounds load at a maximum radius. The bridge travel along the wharf is at the rate of 200 feet per minute. The motion of hoisting or luffing can be operated simultaneously with rotating and traveling motions.

Special Construction Features

The semi-portal bridge supporting the operating mechanism was designed in accordance with the "General Specifications for Street Railway Bridges" issued by the American Railway Engineering Association in 1910, 100 percent being added to all live loads to allow for impact. Ample allowance has been made for the swaying of the load.

Each leg on the wharf side is carried on two wheels, driven through the necessary spur and bevel gearing by the traveling motor. Each pair of wheels is equalized for the proper distribution of load. On the shed rail, the frame is supported by two wheels, one at each corner. The flanges of the wheels running on the shed rails are placed to give about a seven-inch tread. Wheels running on the wharf rail have the flanges spaced to allow proper clearance for the head of the rail upon which they run.

The base frame is made up of rolled steel shapes and well braced plates. The revolving superstructure is carried on six steel rollers, four in front where the heaviest load occurs, and two on the back. A babbitted casting free to rotate about the center pivot pin is attached to the base

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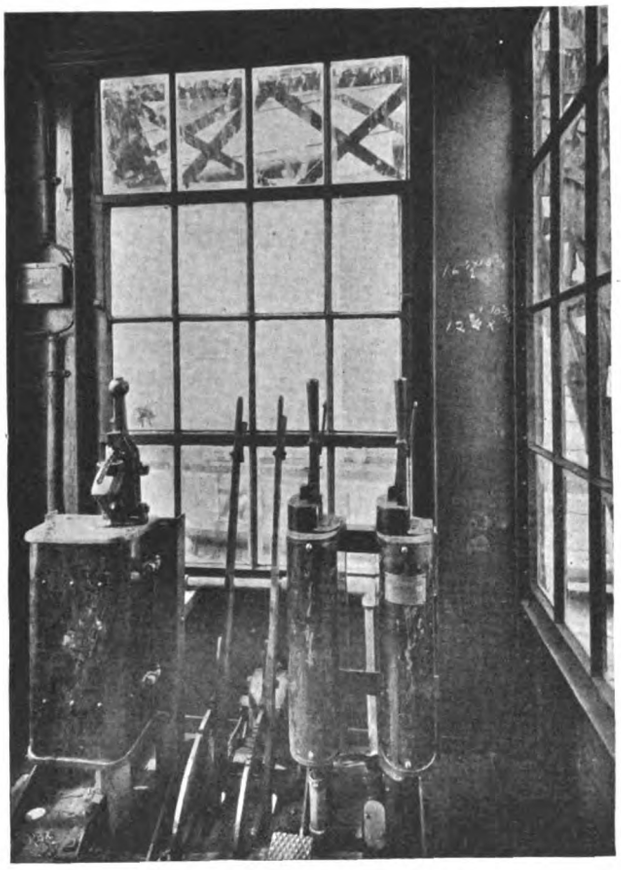

Fig. 2.—Interior of Operator's Cab

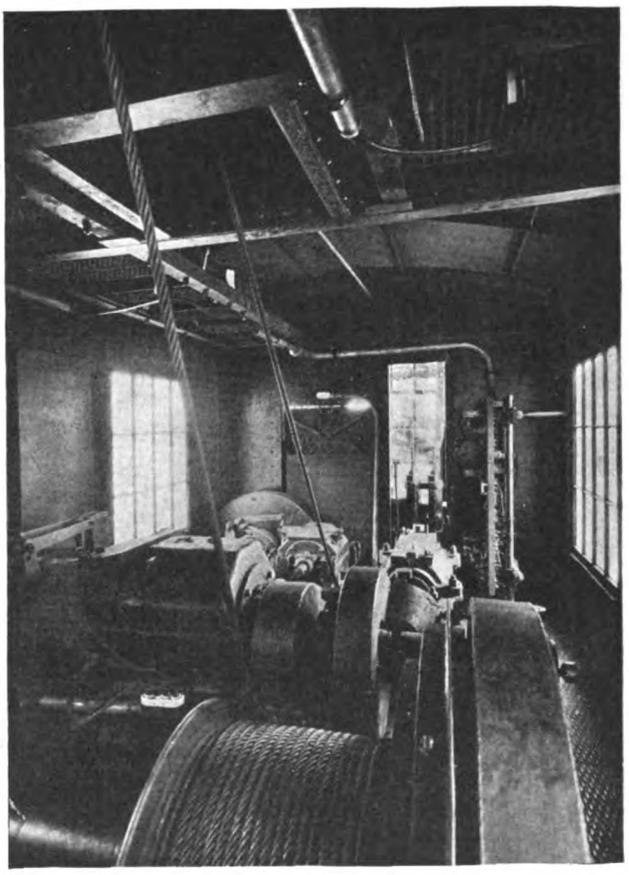

Fig. 3.—Interior of Machinery House

frame to hold the crane concentric with the center pivot pin and to transmit longitudinal and overturning loads from the revolving superstructure to the semi-portal.

The crane is designed so that under normal operating conditions, with a 5,000 pound hook load at the maximum radius, no appreciable load will be thrown on the center pivot load pin. It is, however, designed to transmit any possible vertical or horizontal load from the revolving jib crane to the semi-portal bridge without cramping or binding in any part.

The jib and main frame is made of well stiffened steel plates and shapes. The cab, composed of a steel framework covered with sheet steel, contains the main part of the hoisting, luffing and rotating mechanisms. The operator has an unobstructed view of the load at all times.

Operating Mechanisms

The hoisting and lowering mechanism includes a winding drum, driven through a jaw clutch and a train of spur gearing by a motor equipped with a solenoid break and necessary control apparatus and miscellaneous parts. The luffing of the boom is accomplished by a worm-driven drum operated by the hoisting motor through a jaw clutch and gearing so arranged that the boom can be raised or lowered at the convenience of the operator. The pitch of the worm is such that no mechanical brakes are required to prevent the load from lowering; but, as an additional safety, a pawl is provided to lock the luffing drum in any desired position.

The slewing is accomplished by means of a motor operated through a train of spur and bevel gearing and a pinion meshing with the master gear attached to the semi-portal bridge. A powerful foot brake is provided on this mechanism having a latch, by means of which the brake can be locked for any desired fixed position of the revolving superstructure.

A motor for traveling the bridge is mounted on one of the girders of the semi-portal bridge. One truck on the wharf rail is driven and one wheel on the shed rail. A solenoid brake is mounted on the armature shaft extension. Electrical connections between the conductors on the semi-portable bridge and on the revolving superstructure are made through collector rings mounted on the center pivot pin or an extension. In addition to the solenoid brake, hand operated rail clamps, as illustrated, clamp the wharf rail to hold the bridge in any fixed position.

Electrical Equipment

The electrical equipment is designed for a direct current of 230 volts. The motors, controllers and magnetic brakes are standard equipment of the General Electric Company.

In connection with the clutch shifting lever which en-

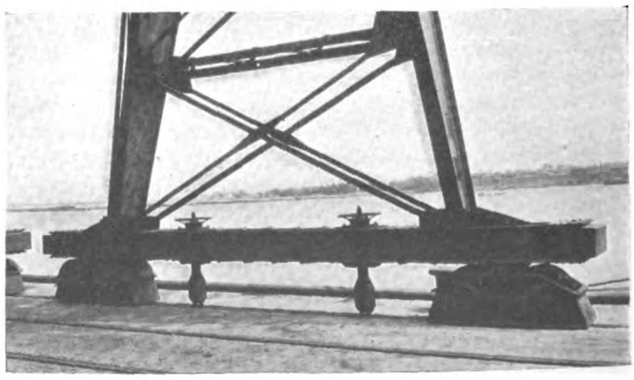

Fig. 4.—Trucks and Hand-Operated Rail Clamps

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gages the hoist and luffing gearings with the driving motor, an interlocking switch, mechanically operated, prevents the starting of the hoist motor without load.

The slewing motor is controlled by a magnetic switch reversing plugging controller, consisting of a control panel, heavy duty, cast grid resister and vertical handle master controller. The plugging feature allows the motor to be reversed from full speed in one direction to full speed in the opposite direction without exerting over approximately 180 percent full load torque.

The bridge motor control, the company claims, provides for slow bridge speeds and also permits accurate control in case a favorable wind may help the motor in traveling, a condition which would ordinarily give an excessive speed.

SAFETY DEVICES

Ample provision is made for the protection of workmen. Guards extending down close to the rails and forming part of the truck brackets are placed in front of the track wheels. All gears are enclosed. Ladders and platforms provide access to mechanical parts of the crane, which are subject to inspection and repair. Hand railings are provided around all platforms. Sheaves are provided with tight fitting guards where necessary. A limit switch is provided to prevent over-travel in the hoisting direction on the main hoist motion. A pressed steel foot gong is provided in the operator's cab for signaling purposes, and a mechanical gong rings continuously when the bridge is in motion.

Launching Vessel in Narrow Waterway at Terry Shipyard, Savannah, Ga.

AT the launching of the 7,500-ton oil tanker *Darden* at the yard of the Terry Shipbuilding Corporation, Port Wentworth, Savannah, Ga., on November 8, 1919, when Mrs. George Baxter, wife of the general superintendent of the yard, christened the vessel, some novel features were used. In the first place, special means of snubbing the ship became necessary, as the river at this point was only slightly wider than the length of the ship. Another novel feature was the use of steel tie plates for holding the sliding ways, which were cut by oxy-acetylene torches for releasing the vessel.

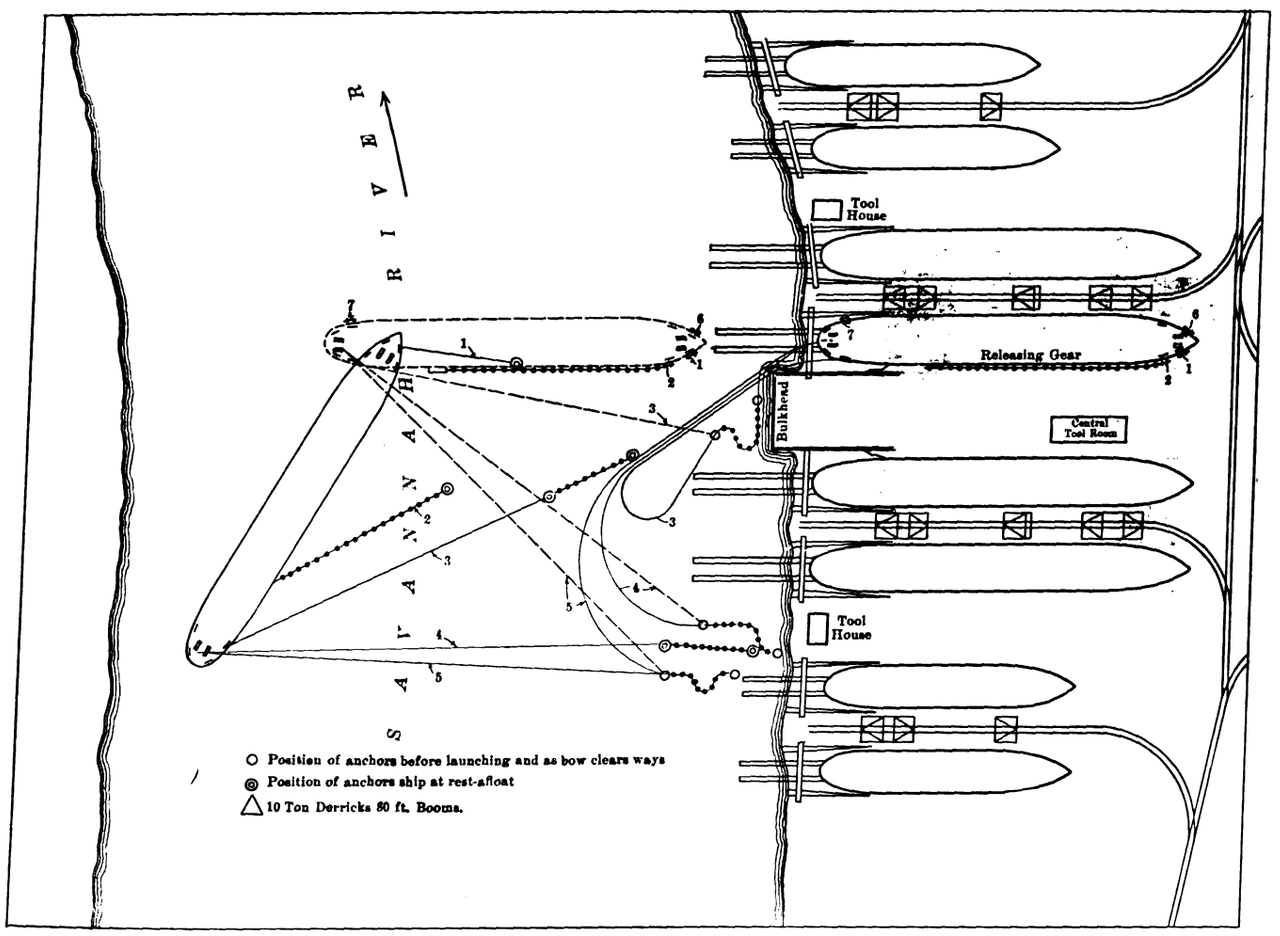

Fig. 1.—Snubbing Diagram

SNUBBING THE SHIP

By referring to the snubbing diagram (Fig. 1), it will be noted that the river is quite narrow at this point, being only 600 feet from the end of the ways to the opposite bank. As the ship was 405 feet long overall, the space in which to swing the ship was quite limited. But this was accomplished very successfully in the following manner, using bower anchors:

No. 1.—An anchor of 4,025 pounds was attached to 150 feet of 7-inch Manilla hawser led through the forward starboard chock to a towing bitt on the forecastle deck.

No. 2.—An anchor of 7,400 pounds was attached to 270 feet of stud link chain, which was lashed to the side of the ship with the end of the chain shackled to releasing

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gear. This gear was bolted to the side of the ship at the second deck between frames supporting watertight bulkheads and arranged to release the chain from the upper deck. This anchor was held in place by rope passing through the after starboard chock to a towing bitt on the forecastle deck. The ropes holding both No. 1 and No. 2 anchors were passed over a chopping block so that they could be cut, as will be explained later.

No. 3.—A steel cable 1¼ inches by 400 feet was led from the forward chock on the starboard side of the poop deck to the first anchor, which weighed 4,025 pounds. A second anchor, weighing 4,725 pounds, was attached to this

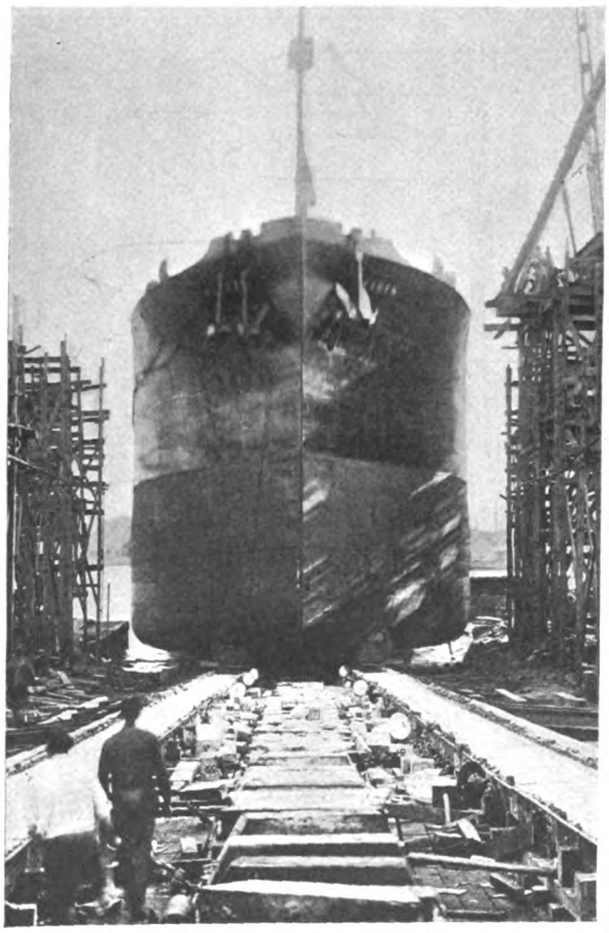

Fig. 2.—The *Darden* Going Down the Ways

cable with 90 feet of chain, laid so that the first anchor would drag 75 feet before taking up on the second anchor.

No. 4.—A steel cable 1¼ inches by 500 feet long was led from the stern frame, through which it passed to the after chock and towing bitt on the port side of the poop deck to the first anchor (weighing 4,025 pounds). A second anchor, weighing 7,400 pounds, was attached to this cable with 90 feet of chain laid so that the first anchor would drag 20 feet before taking up on the second anchor.

No. 5.—A steel cable 1¼ inches by 500 feet long led from the stern frame, through which it passed to the forward chock and towing bitt on the port side of the poop deck to the first anchor (weighing 7,400 pounds). A second anchor, weighing 4,725 pounds, was attached to this cable with 90 feet of chain laid so that the first anchor would drag 20 feet before taking up the second anchor.

Anchors No. 6 and 7, lashed on the port side ready to cut loose, were emergency anchors, but were not used.

At the instant the ship left the ways, as shown in dotted outline (Fig. 1), anchors No. 1 and 2 were cut loose and cables 3, 4 and 5 were pulled up tight on the first anchors. When the ship swung around and came to a stop, as shown in solid outline (Fig. 1), her bow was about in line with the ways and had moved less than her length. All of the anchors had dragged to points shown by a double circle, except those attached to cable No. 5. The first anchor on this cable, forming the pivotal point on which the ship swung, moved less than three feet. The second anchor was not disturbed.

Floats were attached to all anchors and cables in order to locate them readily after being cut loose from the ship.

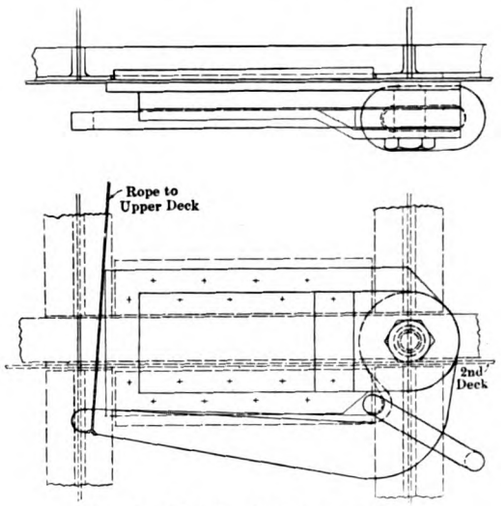

Fig. 3.—Details of Releasing Gear

RELEASING GEAR

The releasing gear was of the pelican hook type operated from the upper deck. It was to be used to release No. 2 anchor in case the ship was brought up too quickly; but, as a matter of fact, it was not used until the ship was at a standstill, when it was released with all other anchors

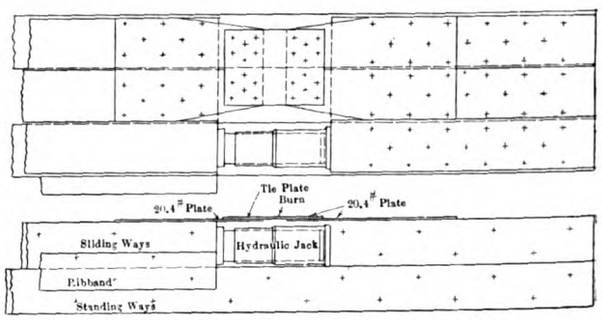

Fig. 4.—Tie Plate, Starboard Launching Way

to enable tugs to take the ship to its fitting dock, where it was tied up and crew dismissed at 10:22 A. M.

The tie plates were 20.4-pound boiler plates rigidly bolted, one end to the standing ways and the other end to the sliding ways, with 6 inches between the ends of the ways. Burning was by means of acetylene torches, the progress of burning being called off in the usual manner.

LAUNCHING PROGRAMME

The launching programme was as follows:

12:01 A. M.	Start cleaning, drying and greasing outboard ways, following the tide out.
7:00	Launching crew report for work.
7:15	Start pulling grease plates
7:35	First rally of 5 minutes on wedges.
7:45	Second rally of 5 minutes on wedges.

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7:55	Third rally of 5 minutes on wedges. Toggles between sliding ways and ribbands removed by each berth gang after completion of third rally. Pour one pint of oil in each space left by removal of grease plates.
8:00	Start splitting keel blocks, removing necessary cribbing.
8:45	All keel blocks out except last twelve, observe and report all creeping.
9:00	Start removing forward keel blocks, stop when creeping exceeds ½ inch. Remove dog shores; all men out from under vessel.
9:12	Start burning tie plates.
9:15	Plates burned, vessel starts.

Senate Merchant Marine Hearings

(*Concluded from page 220.*)

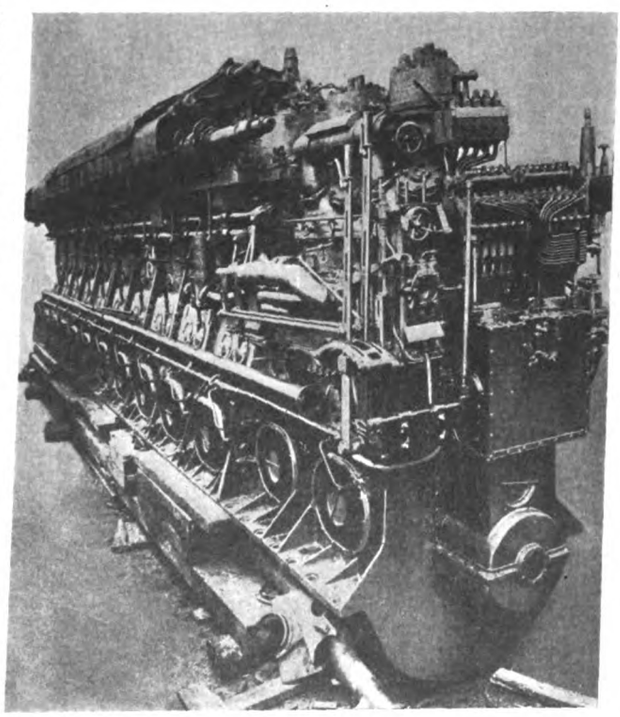
owners in the United States, if offered on terms of 25 percent down and the balance in 15 or 20 years. The Munson executive was, however, very pessimistic as to the possibility of the Government effecting a sale of the 400 wooden vessels on hand. His idea of the best way out of a bad bargain with respect to these wooden ships was to charter the vessels—that is, allow the Shipping Board to charter them on a bare boat basis, prorating that among the ones who had bought or invested their capital in the ships which are now owned by the Government. At a guess, Mr. Munson figured that, by reason of present surplus in the hands of United States ship corporations and money set aside out of earnings in the past ten years for the purchase of building of ships, there is, at the present time, an agregate of perhaps $150,000,000 (£30,800,000) to $200,000,000 (£41,000,000) awaiting investment in ships which would be available for first payments upon Government tonnage should the latter be offered at prices and terms to attract buyers.

This witness combated emphatically the theory that had been advanced to the committee that if the Government vessels were sold control would pass to Wall street. "I do not think," said Mr. Munson, "there is any chance of Wall street ever getting control over the American merchant marine. I am a great believer in the old adage that competition is the life of trade, and I believe if the Shipping Board disposes of all its vessels within the next six months we will see lower rates than we have had in five years." The speaker declared that he felt very strongly that the Government, through the Shipping Board, would be performing a constructive service were it to help the small operators—that is, the modest interests among the 190 operators of vessels under the Emergency Fleet Corporation, to get on their feet and develop organizations as independent ship operators, a status that, in his judgment, they can attain only in the event that they are given the benefit of favorable terms for the acquisition of vessels.

Asked whether the effect of a liberal policy in the disposition of the Government's fleet would be to bring into the field permanently new ship operating interests, Mr. Munson answered emphatically in the affirmative, adding: "I believe that of the 190 operating companies under the Shipping Board today you will find that at least half, not owning a boat today of any kind, would be investing, particularly if the scheme be carried out for Government help in the actual financing of the vessels ordered in American yards." His idea of Federal aid was not confined, either to the disposition of vessels now in the hands of the Government. Rather would the Shipping Board lend moral and financial support to legitimate American ship operating companies that may hereafter desire to order vessels direct from the shipbuilders. This would be accomplished by the Shipping Board saying to the shipowner, as the witness phrased it: "You pay 25 percent down to the shipbuilder and we will take a mortgage on your vessel and you can make the balance of the payments on your vessel to us." The advantage of such an operating plan, as Mr. Munson senses it, is that it would result in the specification of ships of special design for use in special trades which, within the knowledge of the shipowner making the contract, would almost certainly prove profitable.

German Submarine Cruisers

JUST before the armistice, the Germans had practically completed the construction of the first of the submarine cruisers which had been designed some time previously. These boats had a surface displacement of about 2,100 tons and a submerged displacement of 2,600 tons.



3,000 Brake Horsepower, Ten-Cylinder German Submarine Diesel Engine

They were about 305 feet in length, with a beam of 30 feet and a draft of 17 feet.

Although none of them appears to have been put into commission, they are of considerable interest, especially from the point of view of the machinery installation, which is the largest ever contemplated for a Diesel-driven submarine. Two oil engines, each of 3,000 brake horsepower, were used, and an illustration is given of one of these motors, which is by far the highest-powered, high-speed Diesel engine that has ever been constructed for marine purposes. It has ten cylinders with a diameter and a stroke of 20.87 inches (530 millimeters) each and it is designed for an output of 3,000 brake horsepower at just under 400 revolutions per minute, the mean effective pressure in the cylinders being 117 pounds per square inch.

The engine is directly reversible, and maneuvering is controlled by the two vertical levers seen in front of the engine. It is of the four-cycle construction, as employed in the majority of German submarine engines, and, apart from its size, embodies no new principles in Diesel engine design. Two air compressors are fitted at the after end of the engine, and these can be seen in the illustration.

It was anticipated that a speed of about 17 knots would be attained with these boats.

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A Warning

A COWARDLY attempt to benefit by the high standing of this magazine is being made by a publication, issued across the border, which is distributing circulars conveying the impression that they emanated from the office of MARINE ENGINEERING. We caution our advertisers and subscribers not to be caught by this camouflaged bait, for they will get a very cheap, poor imitation of the real MARINE ENGINEERING.

"National Marine Week Stands for American Independence on the Sea—What Do You Stand For?"

WITH the above as a slogan, the National Marine League appeals to the maritime interests of the country in behalf of the exposition to be held in the Grand Central Palace, New York, during the week of April 12 to 17. The appeal is made to advertisers in marine publications to exhibit their products, and already two floors of the big exposition building have been taken for this purpose. More exhibitors are wanted, however, and if the exhibition could be made unanimous, it would be a tremendously effective piece of propaganda for the American shipping industries.

The League has begun the promotion of a national publicity campaign to start the American public thinking seriously upon the problems and possibilities of our merchant marine, and National Marine Week is intended to be a high point in the work. In brief, the National Marine League has undertaken to arouse the people themselves to think in terms of ships and to realize that American cargoes, mails and passengers carried in ships built, owned, operated and manned by Americans, ships classified and insured by American companies, ships equipped and repaired by American industry, are vitally important to the welfare and prosperity of the American nation.

Of the need of the work there can be no doubt, and that the programme of the League is well adapted to carrying out the work is the conclusion of the many able men who have studied the task. The League will gladly receive suggestions along these lines from every American who has our maritime interests at heart. There is room for all, and all are welcome. Will you help?

The Motor Boat Show

THAT the popularity of motor boating as a sport and its usefulness as a commercial industry have not suffered on account of the inactivity in this direction during the war is shown by the enthusiastic attendance and the extent and variety of the exhibits at the fifteenth annual Motor Boat Show, which was held in New York during the last week in February. The experience many young men gained in naval service during the war has served not only to arouse greater interest than ever before in motor boating as a sport but also to create a widespread demand for power craft which possess greater seaworthiness. The straight-line, high-speed pleasure boats are rapidly giving way to vessels with fuller models, sturdier commercial types of engines and ample protection for the helmsman to permit bad weather cruising. Other tendencies which were noticeable in the exhibits were the more general adoption of standardized fittings and the increased popularity of heavy oil engines using a type of fuel less expensive than gasoline (petrol).

Merchant Marine Hearings in Washington

AS pointed out in our last issue, the testimony being presented before the Senate Committee on Commerce in regard to a permanent policy for the merchant marine is conflicting in the extreme. On the one hand representatives of shipbuilding companies and delegates from organizations of shipyard workers are urging the continuance of the present sales policy of the Shipping Board, maintaining prices at more than $200 (41/13/4) a deadweight ton, while, on the other hand, representatives of some of the largest steamship companies in the country are advocating the sale of government ships within a short period at a price around $100 (20/16/8) a deadweight ton, together with exemption from excess taxes, as a measure to enable American shipping to compete successfully with foreign lines. Except for the shipyard workers, who favor reconsideration of cancellations of government contracts and further building for government account, the general opinion is that the government should divorce itself from shipbuilding and shipowning activities as speedily as possible, so that these twin industries may be placed under private control for future development without delay.

The shipowners, apparently, are sincere in their belief that $100 (20/16/8) a ton represents a price for the government-owned cargo ships that cannot be exceeded if American shipowners are to have anything like a fair and even chance in competition with existing foreign tonnage. H. H. Raymond, president of the American Steamship

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Owners' Association, points out that steel cargo steamers, similar in type and most of them probably of greater actual value than the ships of our government emergency fleet, could have been, and were, constructed in this country before the war for about $70 (£14/11/8) a deadweight ton. There were relatively few of these vessels in our merchant marine before the war, but there were thousands of such ships in the merchant fleets of Great Britain, Germany, Norway, France, Holland, Italy and Japan. In fact, some of these steamers were built abroad before the war at a price as low as $40 (£8/6/8) a ton. Great Britain, after all her war losses, still possesses upwards of 20,000,000 deadweight tons of ships that were in service before the war, and the average cost of these vessels, most of which are still serviceable, was well below $60 (£12/10/0) a ton. The high profits of the war period have probably enabled most of the British shipowners to mark their existing tonnage down to a merely nominal valuation. It is with this relatively low-cost shipping of the world's pre-war fleets that the high-cost steamers of the Shipping Board must go into close competition.

To show the handicap under which American shipowners would be placed in such competition, if they are forced to pay from $220 (£45/16/8) to $225 (£46/17/6) a deadweight ton for their ships, Mr. Raymond gives a comparison of the charges on the capital invested in two similar vessels of 10,000 deadweight tons, one furnished to British shipowners by the British government at a cost of $100 (£20/16/8) per ton, and the other furnished to American shipowners by the Shipping Board at a price of $220 (£45/16/8) a ton. The difference in favor of the British vessel based on the three essential factors of insurance, depreciation and interest would be equivalent to 15.6 percent on the cost of the British vessel, while the difference in the cost of wages of officers and crew in favor of the British vessel would probably not be over 20 to 30 percent. As remedies for these conditions, the shipowners suggest that, to offset the difference in charges on capital investment, the government should write down the cost of its vessels to $100 (£20/16/8) a deadweight ton, and to equalize the difference in wage cost, which is a relatively small and probably decreasing factor, an allowance of 10 percent of the net earnings of American ships should be granted on account of depreciation, and the amount deducted as operating expenses in the tax returns. They further suggest that for the important purpose of directly encouraging American shipbuilding ships bought from the Shipping Board and kept under the American flag be exempted from Federal excess profits taxes on condition that an amount equivalent to such exemption be invested by the owner in the purchase of additional tonnage constructed in American yards.

Isherwood System of Ship Construction

OF the many developments which have been made in methods of ship construction during the past twelve years, probably none has had such a far-reaching effect, or been so widely adopted, as the Isherwood system of longitudinal framing. During the twelve years since this system was introduced, nearly 1,300 vessels, totaling 10,573,550 tons deadweight carrying capacity, have been built or are now under construction on the Isherwood system. The following table, showing the number and deadweight tonnage of Isherwood ships built since the system was introduced, serves as a barometer, not only of the Isherwood system itself but of the fluctuating phases of shipbuilding in general throughout the world during this twelve-year period:

Year	Number of Ships	Deadweight Tonnage
Sept., 1907-Dec., 1908	6	31,608
1909	30	181,384
1910	40	271,760
1911	64	474,043
1912	100	618,553
1913	30	215,686
1914	41	358,288
1915	157	1,196,890
1916	152	1,117,779
1917	180	1,655,693
1918	250	2,364,778
1919	210	1,887,079
Totals	1,260	10,573,550

Classifying these vessels according to types, the number of general cargo vessels, colliers, ore steamers, passenger steamships and Great Lake freighters built on the Isherwood system titaled 658, aggregating 5,935,692 tons deadweight carrying capacity. The oil tank steamers totaled 509, aggregating 4,585,608 tons deadweight carrying capacity, and the barges, dredgers and trawlers totaled 93, aggregating 52,250 tons deadweight carrying capacity.

During the year 1919 there were on the ways at the various shipyards of Great Britain and the United States more than 400 ships of the Isherwood type. Among these vessels there were no less than 150 oil tankers, which, when finished, will be capable of transporting over 8,000,000 tons of fuel oil during the year. Incidentally, these 150 tankers—many of them over 10,000 tons deadweight capacity—comprise the whole of the world's contracts for oil tankers given out in 1919. Today there are no fewer than 509 oil tankers built and building on the Isherwood system, and those which were afloat during the war carried the major portion of the oil required by the Allies for land and sea service.

Shortly after the conclusion of the armistice, it was estimated that during 1920 there would be a world deficit of at least one million tons of oil-carrying shipping as against the demands for oil fuel supplies. That this estimate was to all intents and purposes an accurate gage of the year's requirements is shown by the fact that the leading oil companies are now ordering tankers in unprecedented numbers, all under high-pressure construction orders, from the principal shipyards in this country, in Great Britain and on the Continent. It is significant that a very large percentage of the orders for the tankers has gone to American shipyards. With the contemplated additions during the present year there will be afloat towards the close of 1920 more than 4,500,000 tons deadweight of Isherwood type vessels devoted to carrying nearly the whole of the world's oil supplies.

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Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Value of the Ejector

Mr. F. C. Getliffe's letter on page 71 of the January issue interested me very much, for some years ago I was in a ship that almost foundered, due to the pumps becoming choked with coal dust that had run into the bilges. However, "a miss is as good as a mile." We did not go down, but if we had had an ejector as suggested by your correspondent, lots of hard labor and anxiety would have been saved us during that voyage.

Briefly, this is what happened. We were laden with bag sugar from British Guiana, South America, bound for Philadelphia, Pa., where the raw sugar was to be refined. We were laden very deep—in fact, to the limit. When off Hatteras we ran into a storm (it was in March) and the ship tumbled around considerably, although so deeply laden. Our midship coal bunker had been emptied, excepting for the usual sweepings which remained, and the water in the bilge during the rolling dislodged the bunker flooring, which, strange as it may appear, had not been secured to the framing and keelsons of the ship. Of course, what coal there was in that bunker ran down into the bilge, through the limbers, into the engine room bilge, and very soon choked up the rose boxes or strainers and soon put the engine bilge pumps out of business. The water was black with coal dust.

After the engine pumps gave out we started up the independent donkey pump, which had a 6-inch suction. The rose box of that pump also soon got choked up, and the valves in the pump as well. However, that was the only pump we had for the purpose, and, of course, we did not want to resort to the bilge injection, unless it were a case of life or death, so the firemen took turns at keeping the rose box clear, while the engineers kept the pump valves working.

This pump was on the port side of the ship, and when the ship rolled to port the water was so deep that we could do nothing in the way of keeping strainer and pump valves clear. When the ship rolled to starboard, the port side was fairly free from water, so we hastily cleared the rose box and cleared out the pump valves (by taking off and putting on, alternately, the value chest cover of the water end, which, temporarily, we secured with two nuts only) while the ship was in that position.

This procedure was kept up for a whole day without cessation. We just about managed to keep the water from gaining, and nothing to spare. The water was cold, as might be expected at that time of the year, and all hands were pretty well used up. However, we ran out of the storm during the third day, and when the ship ceased rolling violently we soon cleared all the pumps and got rid of the water in a short while.

Now, if we only had had an ejector as described by Mr. Getliffe we would have mastered the situation with much less trouble, and in less time. Not any of us thought about an ejector at the time, but even if we had, there was not anything on board with which to make a "home-made" ejector, nor did we have the pipe tools with which to make such a device. I am strongly of the opinion that every ship should have both *ejectors* and *injectors*, just for possible emergencies that may arise. Many steam power plants on land have both these valuable pieces of apparatus for possible emergencies. They are not expensive to install and they have no parts that are liable to get out of order very quickly.

Brooklyn, N. Y. CHARLES J. MASON.

"Pointing Off" When Using the Slide Rule

The hardest thing for a beginner to learn about the operation of a slide rule is to keep track of his decimal point.

The method used in long-hand, of starting at the right and point off to the left, will not work at all on a slide rule, as the entire number of figures is not always known, due to the fact that the average rule can be read to only three or four places.

The following rule does not take into consideration the figures to the right of the decimal point except in the case of fractions. It is very simple and is so short that it can be marked on the back of your slide rule and therefore does not even have to be memorized.

It is:

Sum of the Characteristics <— Multiplication —> Sum of the Characteristics minus 1

Difference of the Characteristics <— Division —> Difference of the Characteristics plus 1

The arrow indicating the direction the slide is pointing.

The characteristic of a whole number is the number of digits to the left of the decimal point. Thus the characteristic of 25.74 is plus 2. The characteristic of a fraction is the number of zeros between the decimal point and the first significant figure. Thus .2574 has a characteristic of plus or minus 0, for there are no digits to the left of the decimal point and there are no zeros between the decimal point and the first significant figure, while .0002574 has a characteristic of minus 3, for there are three zeros between the decimal point and 2, the first significant figure.

When the sum or the difference of the characteristics of two figures is to be obtained, it should always be the algebraic sum. Thus, 2 plus (minus 3) equals minus 1, or 2 minus (minus 3) equals plus 5.

Take, for example, $25.74 \times .0682$. The characteristic of 25.74 is plus 2, and that of .0682 is minus 1. The slide extends to the left, and, as this is multiplication, it should be the sum of the characteristics. Hence, plus 2 plus (minus 1) equals plus 1, which means that the answer will contain one digit to the left of the decimal point or 1.76.

Suppose that this had been division, that is, 25.74 divided by .0682, the characteristics of both members remain the same. The slide still extends to the left, but as this is division it is the difference of the characteristics,

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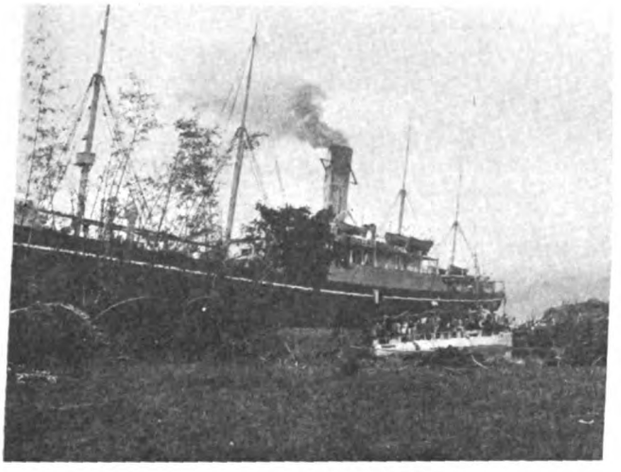
or plus 2 minus (minus 1) equals plus 3, and the answer becomes 377.4.

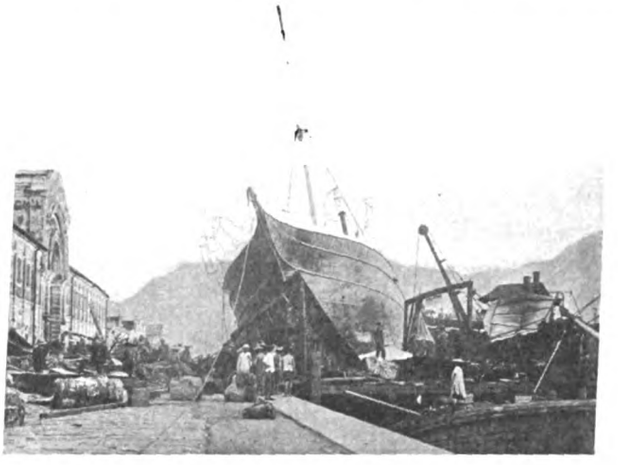
Take another example of multiplication: .1268 × 71.5. The slide extends to the right so the rule says sum of the characteristics minus 1. The characteristic of .1268 is 0, and that of 71.5 is plus 2. The sum is plus 2 plus 0 equals plus 2, but it is the sum minus 1, or plus 2 minus 1 equals plus 1, and the answer is 9.06.

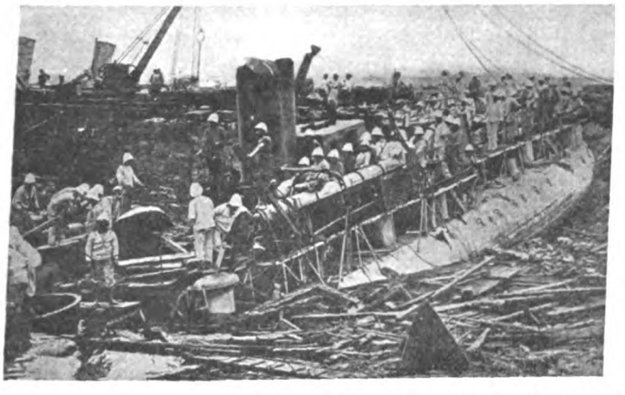
Another example of division: .00925 divided by 12.5. The characteristic of .00925 is minus 2, and that of 12.5 is plus 2. The slide extends to the right, and, as this is division, the rule says the difference of the characteristics plus 1, or minus 2 plus (minus 2) equals minus 4, but it is the difference plus 1, or minus 4 plus 1 equals minus 3 and the answer is .00074.

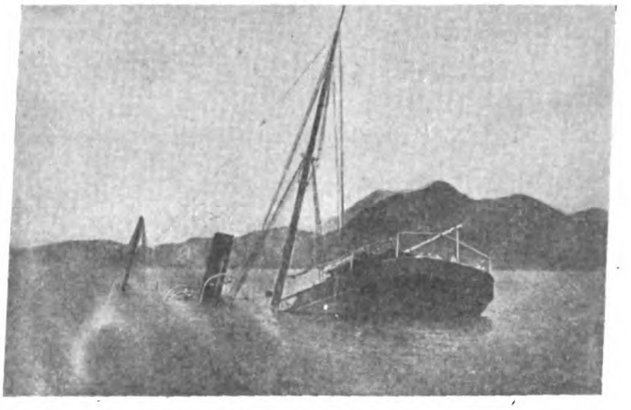
Any number of examples might be given, but as these four cover every possible use of the rule the reader is left to practice with examples of his own manufacture.

Jacksonville, Fla. B. W. MANIER.









Views of Damage to Shipping in Hong Kong Harbor Caused by Typhoon in 1906

Shipwrecked at the Dock in a Typhoon

While sailing the Seven Seas it has been my good fortune to weather many a bad storm, and so to have my narrowest escape from shipwreck and sudden death occur while loading cargo in the port of Hong Kong may seem strange, to say the least.

We had been lying-to for several days, together with some four hundred and fifty other vessels, making the most of good weather to unload or take on another cargo before clearing for home. On the morning of September 6, 1906, our ship, of 8,700 deadweight tons, was nearly loaded, when out of an apparently clear sky a terrific typhoon struck us. The fires in the boilers had been banked two or three days before, so when we tried to get up steam in a hurry to keep the ship headed into the wind we failed hopelessly. As a result, even with three anchors out, we piled up against the dock and nearly wrecked the Custom House.

When the typhoon had blown itself out the harbor of Hong Kong presented a rather chaotic appearance. About $10,000,000 (£2,050,000) damage had been done and over 1,200 lives lost.

The fact that no previous warning of the storm had been given seemed a rather strange occurrence for a port of the importance of Hong Kong. It was later discovered that the observatories at Shanghai and Hong Kong were in the midst of a private feud and were not on such terms that weather reports might be exchanged.

Swapping yarns some time after the disaster with another engineer who had been in the port at the time, he declared that he was half tempted to connect the engines of his ship to one of the ventilators when he found that he could not get up steam in time to keep them off shore.

G. J. L.

Removing a Key

I read your paper every month and like it very much. I like the letters best, as I am learning the machinist's trade and so get ideas from the letters.

A man who has been at the trade for more than twenty years told me he never saw a key got out the way my boss got one out, so I thought I would write you about it.

My boss is Lem Baker and I have worked with him for

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six months. We had to take the coupling off an eight-inch shaft. Lem and a helper and I started to do the work, but instead of trying to drift out the key with a sledge, Lem filed the end of the key on top to a taper, where it stuck out about an inch, taking off about an eighth at the end. Next he got a very narrow cape chisel and chipped down each side of the key at its end, back about a quarter, close to the sides of the key way. Then he used the drift, the helper doing the striking, and the key came out easy because the end did not upset all the time we were drifting.

The man who had been at the trade twenty years said it was just common sense, which many people do not have in the machinist trade.

New London, Conn. JAMES MURRAY.

Nut-Holding Device

This little trick can be employed to good advantage by any mechanic, therefore I pass it along. When putting in or taking out bolts and nuts in restricted places in and about machinery parts, it is sometimes necessary to employ a

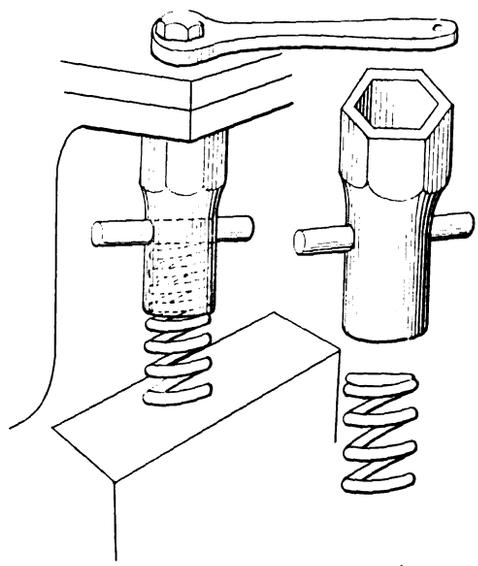


Fig. 1.—Sketch of Nut-Holding Device

helper to hold the bolt from turning while tightening the nut. By making a short length socket wrench from a piece of steel tubing or pipe and putting a short rod through it, as shown in Fig. I, and obtaining a spring that will fit in the pipe and force the wrench in place, you will have a little device that is equal to a helper for this work.

A block of wood is used to build up the distance under the spring when not possible to set it directly against a machine part. The rod in the socket wrench brings up against the casting or adjacent part of the machine, thus holding the wrench from turning.

Concord, N. H. C. H. WILLEY.

Designating Machine Finish

There has come to my attention a system that a certain drafting room uses to designate the grade of "finish" which they desire on machine parts. In this system the symbol ordinarily used for "finish" is given a power or exponent, such as f^1 or f^2, etc. These small figures placed to the right, a little above the ordinary finish mark, determine the certain class of finish desired, as shown in Fig. 1.

In order that the workman in the shop may correctly understand the meaning of the finish mark exponents,

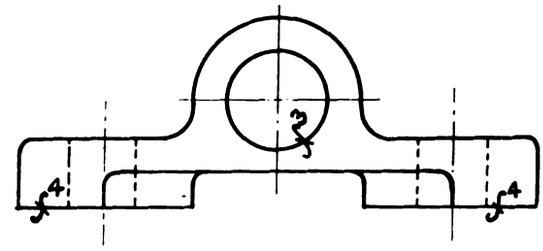


Fig. 1

their definition is stamped on the tracing in the drafting room, so that on each print which goes to the shop there is included the following key, or table:

KEY TO FINISHES

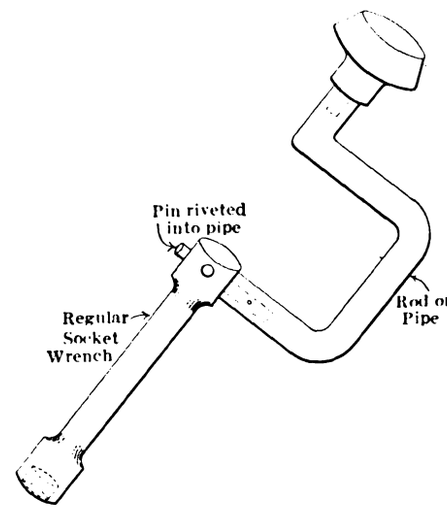
f^1—Water-cooled grind or lap.
f^2—Dry machine grind.
f^3—Smooth machine.
f^4—Finishing cut.
f^5—Rough cut.
f^6—Hand grind or file.

Thus a draftsman can very easily and conveniently express in a simple manner the particular quality of finish he wants on any surface of a machine part.

Portsmouth, Va. PETER PETROVSKY.

Socket Wrench Crank

Quite often one meets with a job that requires the removal and replacing of many nuts of the same size. Much time can be saved if a special brace wrench can be used. When it is not possible to find such a wrench at hand, a socket wrench can be used by making an attachment, consisting of a crank made of pipe or tubing with



Improvised Brace

a short piece of rod to fit the hole through the socket wrench end, and a knob to fit in as a breast plate. The idea is conveyed better in the illustration than words can describe it. MACHINIST'S MATE.

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Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Preliminary Computations for Marine Steam Engine

Q. (1032).—Given the following data for a triple-expansion marine engine: 26-inch by 43-inch by 71-inch cylinders and 48-inch stroke; boiler pressure, 180 pounds gage; cut-off, .67, .67 and .63 respectively on the high-, intermediate- and low-pressure cylinders; diameter of piston rod, 7½ inches; revolutions per minute, 80; factor for probable mean effective pressure, .70.

Please work out the ratio of expansion; mean effective pressure; actual mean effective pressure referred to low-pressure cylinder; indicated horsepower; mean effective pressure in each cylinder assuming equal work; terminal pressure in each cylinder at cut-off; and steam admitted per stroke. Kindly give formulas. M. B.

A. (1032).—In making a preliminary calculation for the dimensions of an engine, it is customary to neglect the size of piston rod when considering the cylinder sizes. It is also supposed that the cylinder dimensions will be obtained from their ratios to the high-pressure cylinder, which would be given in the data together with cut-off, indicated horsepower, piston speed, and factor for mean effective pressure. Below you will find the calculations as commonly carried out in a preliminary computation (i. e., area of the piston rod neglected); the results in the parentheses show the effect of allowing for the piston rod, which should be considered in a careful computation of strength or power, as, for instance, finding the indicated horsepower of an engine in existence when the cards have been obtained.

Number of expansions:

$$n = cR = \frac{1}{.67} \times \frac{\pi/4\ (71)^2}{\pi/4\ (26)^2} = 11.1. \qquad (11.5)$$

Mean effective pressure referred to low-pressure cylinder:

$$M.\ E.\ P. = P_1 \frac{1}{h}(1 + \log_e n) - P_2.$$

$$= \frac{194.7}{11.1}(1 + 2.408) - 5.0.$$

$$= 59.8 - 5.0 = 54.8. \qquad (53.0 \text{ pounds})$$

Probable mean effective pressure referred to low-pressure cylinder:

Probable

$$M.\ E.\ P. = .70\ M.\ E.\ P.$$

$$= .70 \times 54.8 = 38.4 \text{ pounds.} \qquad (37.1 \text{ pounds})$$

Mean effective pressure, each cylinder for equal work:

$$L.\ P. = \frac{38.4}{3} = 12.8 \text{ pounds.} \qquad (12.4 \text{ pounds})$$

$$I.\ P. = 12.8 \times \frac{\pi/4\ (71)^2}{\pi/4\ (43)^2} = 34.9 \text{ pounds.} \qquad (34.1 \text{ pounds})$$

$$H.\ P. = 12.8 \times \frac{\pi/4\ (71)^2}{\pi/4\ (26)^2} = 95.3 \text{ pounds.} \qquad (95.8 \text{ pounds})$$

Theoretical pressure in each cylinder at cut-off:

$$(H.\ P.)\ P_c = P_1 \frac{C_h}{C_l} \times \frac{D_h}{D_l}$$

$$= 194.7 \left(\frac{.67}{.67}\right) \times \frac{\pi/4\ (26)^2}{\pi/4\ (43)^2} = 71.4 \text{ pounds.} \qquad (69.3 \text{ pounds})$$

$$(I.\ P.)\ P_c = 194.7 \left(\frac{.67}{.63}\right) \times \frac{\pi/4\ (26)^2}{\pi/4\ (71)^2} = 27.8 \text{ pounds.} \qquad (26.8 \text{ pounds})$$

Steam volume of high-pressure cylinder at cut-off, assuming no clearance:

$$\text{Volume} = \frac{\pi d^2}{4} \times \frac{4 \times .67}{.144} = 9.89 \text{ cubic feet of steam per stroke.} \qquad (9.47 \text{ cubic feet})$$

The weight of steam admitted at each stroke can be approximated, if we assume the steam dry and look up the specific volume of steam at the cut-off pressure.

Safety Valve Problem

Q. (1034).—Will you kindly figure the following problem as closely as possible: Diameter of valve, 2½ inches; pressure, 81 pounds; distance of valve from fulcrum, 3 inches; weight of lever, 3 pounds; one-half length of lever, 12 inches; weight of valve and stem, 3 pounds; length of lever, 24 inches.

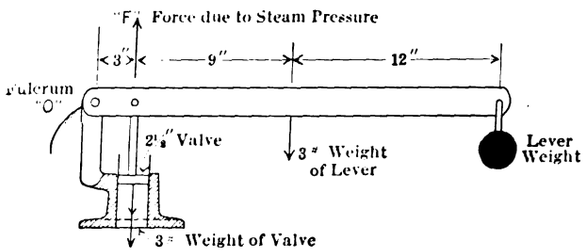
Find lever weight. B. B.

A. (1034).—The steam pressure will exert the force F determined as indicated below:

Area over which the steam acts is that of a 2½-inch circle, or

$$\pi \frac{d^2}{4} = \frac{3.14}{4} \times \frac{25}{4} = 4.91 \text{ square inches.}$$

Force $F = 4.91 \times 81 = 397$ pounds.



We will now take moments of all the forces about the fulcrum O in the figure:

Anti-clockwise moment $= 397 \times 3 = 1{,}191$ inch-pounds.

Clockwise moments—

Moment of valve and stem $= 3 \times 3 = 9$ inch-pounds.
Moment of weight of lever $= 3 \times 12 = 36$ inch-pounds.
Moment of lever weight $= 24 \times W = 24W$ inch-pounds.
Total clockwise moments $= 45 + 24W$ inch-pounds.

It is clear that for the safety valve to be on the point of lifting, the anti-clockwise moments and the clockwise moments about O must be equal. If we equate same, we can now solve, for the value of W, the lever weight:

$$45 + 24W = 1{,}191.$$

$$W = \frac{1{,}191 - 45}{24} = \frac{1{,}146}{24} = 47.7 \text{ pounds (weight required at end of lever).}$$

We have here assumed that it was intended to place the weight at the end of the lever. Should it be desired to locate it at some other distance from the fulcrum O, the solution can be carried out by replacing the arm 24 inches by the above distance.

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Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

GULF COAST SHIPYARDS SEE PROSPERITY AHEAD

Southern Concerns Full of Business, With Big Mobile Plant Booked Up for Years on British Contracts—Launchings of a Ship a Month Expected.

British capital, says a Mobile, Ala., authority, has offered to the Mobile Shipbuilding Company a contract for the construction of between twenty and twenty-five bulk oil carriers, which will require two years to fill. The efficiency of the plant is being increased so that ships can be turned out faster, and H. L. Brittain, president of the Mobile Shipbuilding Company and the Birmingham, Ala., Steel Corporation, announces that plans are being made to increase the output of the concern between 25 and 40 percent within the next few months.

Mr. Brittain, who is in close touch with shipbuilding concerns all over the country, because of his position as one of the five shipbuilders on the general committee which meets with five international presidents to fix all wages, hours and conditions in the various shipbuilding plants of the country, stated that all the big concerns of the country had work in sight to take their output for the next five years.

"Contracts now let or under negotiation by the Moshico plant will consume the capacity of the local plant for the next four or five years," he said. "The Mobile Shipbuilding Company is here to stay, and it must be reckoned as one of the great industrial concerns of the city.

"Provided the material situation does not get so bad that we can't get out steel requirements," said Mr. Brittain, "ships will be built here in ever-increasing numbers. The Birmingham plant has been held up on account of steel, and our present contracts are in the same fix. The situation will take a better turn soon, I hope, and then we may figure on future work."

No Let-Up At the Yards

"There will be no let-up in the yards here," declared Mr. Brittain. "We shall operate to the end of this year on contracts already placed with us, and not on contracts still ungained. The programme for 1920 is pretty well mapped out. We intend to finish all our work for the Emergency Fleet Corporation before January 1, 1921, and to close the year here with the construction of ships for private shippers and foreign companies.

"All our ships will be oil burning in the future. The five ships now on the ways will burn fuel oil, and so will the two already launched. Oil has just been received for the dock trial of the *Minooka*, and we expect a still larger shipment of oil so that she may make her sea trial within the next two weeks. The *Hutchinson*, the other ship now on the equipping dock, is twenty days behind the *Minooka*, but she too should be turned over about the first of March.

More Men, More Business

"A considerable increase will be made in the operating force employed at Moshico. It is now a question with us of taking the business most profitable to the yards. What we want is to have the Moshico do larger business for a longer period of time. The demand now is enormous for oil tankers, and we shall concentrate our efforts on the construction of those. England is coming over here to place her contracts for oil tankers, and every big concern has been offered one of these British contracts."

Mr. Brittain added that as the concern was now reaching the point where it could turn out a 5,000-ton ship a month, the cost of each, as well as the time taken for construction, was being reduced. He also said that probably two or three standard types of ships would be built, and these alone.

"The demand for ships," he concluded, "is as great now as during the time when the German submarines were operating. The Government is not demanding them, it is the private concerns. We are not called on to make so many in so short a time, but everything we can turn out will be taken."

Mobile Launchings Scheduled

Ten ships are on ways in Mobile having a tonnage of 70,300, an increase of 10,000 tons over the tonnage launched during the entire year of 1919. At the Chickasaw Company's yard, the *Birmingham City* will be launched this month, and a celebration will be held at that time. February 17 has been named as a tentative date. The next of the three ships now on the ways at Chickasaw to be launched will be the *Mobile City*.

Five steel ships are under construction at Moshico. The *Oklahoma City* will be the only one launched this month, while the *Capital of Nebraska* will be the next. The aim of the Mobile Shipbuilding Company is to launch one of their new ships every month.

So much work remains to be done on the *Marei* at the Alabama Company's plant that it may be March before the vessel is launched. Officials of the company state that it is much easier and less expensive to install the machinery before the vessel goes into the water.

PASSENGER SHIP PLANS

Porto Rico, Red D and Munson Lines May Build

Plans for passenger ships for the New York & Porto Rico Steamship Company, 11 Broadway, the Red D Line, 82 Wall street, and the Munson Steamship Line, 82 Beaver street, are nearing completion, according to an announcement this week, and it is understood that the shipbuilders will be asked to submit bids for the vessels at an early date. According to reports, the Red D Line is planning to have two 5,000-ton passenger ships, having a speed of about 14 or 15 knots, built.

It has been known that the New York & Porto Rico Line was figuring on at least two oil-burning passenger liners for service to the West Indies. The ships are to be about 400 feet long, and are to be fitted out with luxurious appointments.

Little information can be obtained regarding the two vessels projected for the Munson Steamship Line. It is generally understood that they will be designed to meet tropical requirements.

The plans for all six ships are being drawn up by Theodore Ferris, according to shipbuilders. The companies concerned are reluctant to talk regarding passenger ships, and generally state that they will not build unless prices are reasonable enough to warrant construction.

Building Eight Steamers at New Orleans

The steamer *New Orleans*, launched late in January at the yards of the Doullut & Williams Shipbuilding Company, New Orleans, La., was the first of eight vessels to be built by the yard for the Shipping Board Emergency Fleet Corporation. Three others will be launched at intervals of thirty days each.

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HOG ISLAND'S RECORD IN AMERICAN SHIP BUILDING

What Has Been Accomplished at the Great Plant Since Work Began in September, 1917—More Than 660,000 Tons Launched

While there has been considerable discussion as to the great plant of the American International Shipbuilding Corporation at Hog Island, Pa., few people are fully aware of the remarkable record made there since construction began. The following illuminating figures are supplied to SHIPS AND SHIPPING by Mr. M. C. Brush, president of the corporation, and are a valuable addition to the record of American shipbuilding. They complete the record to January 31, 1920:

Contract signed	September 13, 1917
Actual construction begun	September 20, 1917
First keel laid	February 12, 1918
First ship launched	August 5, 1918
World launching record of 5 ships in 48 minutes, 10 seconds	May 30, 1919
Area of Hog Island	927 acres
Number of ways	50
Number of piers	7 (1,000 ft. long and 100 ft. wide)
Number of men employed	22,000
Number of rivets driven to date	54,113,839
Length of water front, miles	2¼
Length of railroad tracks, miles	82
Number of warehouses	36
Floor space of all buildings, acres	103
Number of concerns who furnished supplies to construct yard	3,500
Lumber used	150,000,000 feet
Piles driven	151,000
Amount of water filtered and chlorinated	1,300,000 gallons daily
Length of water piping	29 miles
Length of sewers and drains	26 miles
Length of wiring	675 miles
Length of telephone wiring	3,000 miles
Capacity of load—compressed air	74,000 cubic feet
83 Ships launched to date with highest rating of Lloyd's and American Bureau. Total deadweight tons	660,175
70 Ships delivered to date with highest rating of Lloyd's and American Bureau. Total deadweight tons	547,750
Which have steamed over 1,000,000 miles and carried over 800,000 tons of cargo.	
Total tonnage launched, "A"—1919	485,150 D. W. tons
Total tonnage launched, "B"—1919	32,000 D. W. tons } 517,150
Total tonnage delivered—1919	500,800 D. W. tons
Total working days	278 1/5
Total working hours	2,228
D. W. tons launched per 8-hour day	1,850
D. W. tons delivered per 8-hour day	1,798

One ship launched every 4¼ working days, or 34 working hours.
One ship delivered every 4⅜ working days, or 35 working hours.

CITY TAKES TERMINAL

Long Island City Will Have Big Public Dock

The new State barge canal terminal at Nott avenue and the East River, Long Island City, has been taken over from the contractors by Edward Walsh, New York State Superintendent of Public Works, and as soon as the necessary men to operate it can be obtained it will be available for use.

Commissioner Walsh plans to throw the terminal open to the manufacturers and business men of the district for use as a public dock. State canal barges will be landed there as well as all the shipping the manufacturers may have. Two harbor masters will be appointed, to be in charge of the terminals, and the equipment for the expeditious and economical handling of freight is said to be up to the minute in completeness.

Pascagoula to Build Steel

To meet changed conditions following the close of the war, the building of wooden ships has been abandoned at the plant of the International Shipbuilding Company at Pascagoula, Miss., for a time at least. The building of steel ships will continue at the plant without interruption, it has been stated by one of the officers of the company.

It is claimed that the building of wooden ships, with the present high price of labor and material, has been carried on at a loss, and therefore, until conditions change, will be dropped for a time. There is one wooden ship on the ways at the yard now, and this will be completed.

20,000-TON TANKERS

Standard Oil Company of New Jersey Orders Two

The Standard Oil Company of New Jersey, 26 Broadway, has just placed a contract with the Newport News Dry Dock & Shipbuilding Company for two 20,000-ton tankers. These will be the largest tankers in the world, the largest afloat to-day being of 18,500 deadweight tons. Before the war the largest tankers were about 15,000 tons, all built with Isherwood framing.

It is also reported, but not confirmed, that a duplicate order has been placed with the Sparrows Point plant of the Bethlehem Shipbuilding Corporation, Ltd.

To Build Molasses Tankers

The Staten Island Shipbuilding Company has received contracts for two molasses tankers, of 6,300 deadweight tons each, from the American Sugar Refining Company of New Jersey, 117 Wall street, this city.

DELAWARE RIVER WORK

Hog Island the Only Yard Without Orders Far Ahead

In a description of the Delaware River shipbuilding district, which he speaks of as the permanently established shipbuilding centre of the world, a writer in the Philadelphia North American, presents a cheerful forecast for the next year, saying that all the yards except Hog Island have orders far ahead. He continues:

Shipworkers in the Philadelphia district are assured of continuous employment, without reductions in force, for more than a year ahead. At only one of the Delaware River shipyards is there any doubt as to the labor demands of the immediate future. That doubt surrounds Hog Island, whose contract with the Emergency Fleet Corporation will have been completed by mid-summer. It employs more than 20,000 workmen.

The management of every other shipyard of the district are unanimous in an optimistic outlook for the industry. Orders are actually on hand to keep the yards at capacity for months; in instances the yard facilities and working forces have been increased, and further expansions will be necessary as soon as foreign exchange becomes stabilized and starts its march towards normal.

The New York Shipbuilding Corporation, at Camden, now lays claim to being the world's largest, completely equipped shipbuilding yard. At the time of the armistice it had 13,500 men on its operating force; this force within recent months has been reorganized and increased to 19,000 men. Contracts on hand guarantee capacity employment for the remainder of the year.

The optimism of the Sun Shipbuilding Corporation, at Chester, is materially illustrated by the fact that two new ways are under construction to help care for the great mass of work scheduled, which will keep between 6,000 and 7,000 men busy for at least two and one-half years. The new ways will be done by July, when the keels for two ships immediately will be laid upon them.

The Merchant Shipbuilding Corporation, with yards at Bristol and at Chester, report sufficient work to keep the present force running at full capacity for another year and a half. Two 12,500-ton freighters and four 10,500-ton tankers are under actual contract for private concerns at Chester. The company additionally has under order from the Emergency Fleet Corporation eleven fabricated ships, of which the keels have not as yet been laid for four.

Nor is the Pusey & Jones Company, of Gloucester, in the least behind its sister yards. Contracts are under way to keep 4,000 workmen busy for the remainder of the year, while English contracts are being taken for two years ahead of this date. Five ships will be completed here in August, closing out the Emergency Fleet contract.

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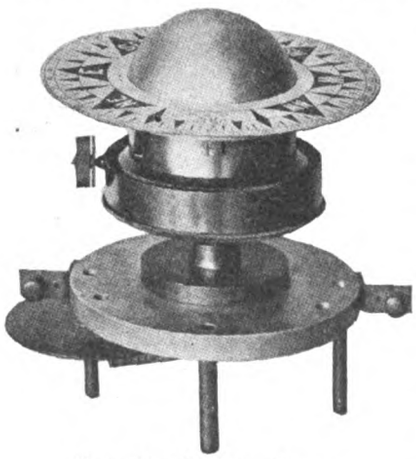
IMPROVED APPLIANCES

New Non-Magnetic Compass Invented

A compass which is non-magnetic and does not depend on gyroscopic action for its pole-finding properties is being exhibited by R. E. Bibbins, at Room 1722, 150 Nassau street, New York City.

The device consists of two separate units—a steel vessel and a ball. The vessel floats freely around a vertical guide while the ball which is contained in the vessel is rotated at high velocity by a stream of compressed air led into the vessel and impelled against the side of the ball. A nozzle, made of agate to resist wear, is placed in the bottom of the cup, to render the direction of air-flow constant. Because of this fact, the ball rotates on an imaginary axis, while



New Non-Magnetic Compass Earth's Motion Reproduced

it is floated in an air gap free of all connection with the containing vessel. If the propelling air is properly adjusted to the correct spin of the ball, the motion of the earth is simulated; that is, the current of air passes around an equator while the ball rotates on its imaginary axis.

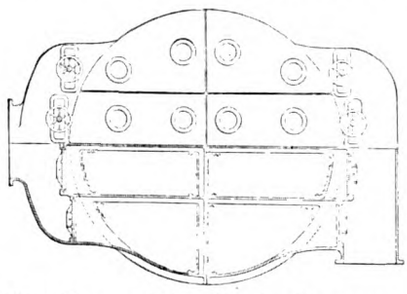
In setting up this compass for navigation, surveying or similar purposes, the device is so adjusted that the revolution of the ball in the line of its equator corresponds closely to the rotation of the earth from west to east. It follows that the axis of the ball, being at right angles to this rotation, runs due north and south. In other words, the axis of the ball and the compass card attached to the vessel indicates the meridian of the locality in which the compass is located.

As long as the stream of air is supplied to the chamber, the ball will continue to rotate in the line of its equator unless some outside force is supplied to displace the compass temporarily from its normal position.

In explanation of the ability of this compass to indicate true north at all times, the inventors state that the daily revolution of the earth on its axis and the revolution of the air-driven ball are in the same plane when the axis of the ball is coincident with the meredian. This daily revolution exerts a constant tendency to tip the supporting vessel, like everything else on the earth's surface, so that it will perform the same revolution in space as the earth does, and with the same angular velocity as the earth. The ball, however, does not partake of this tipping to the same extent as the vessel, if at all, being disconnected from the vessel (it is floating in the air gap). Gravity is counterbalanced by the supporting force of the air which drives the ball. The angular velocity depends naturally upon the force of the stream of air which impinges on its side. When this is properly attuned to the size and weight of the ball and other features of the device, a force is exerted against the pull of the earth to tip the vessel, tending to maintain the position of the ball on the meridian. The resultant of these two forces (the rotation of the ball and the tipping tendency of the earth) is a single force which turns the vessel around the vertical air guide instead of tipping it away from the rotating ball. This force manifests itself in a procession of the compass, which does not stop until its position in the line of the meridian has been regained.

New Type of Condenser

A recent development in steam surface condensers has been announced by the Wheeler Condenser & Engineering Company, of Carteret, N. J. It is a compartment condenser which may be cleaned while in service without interrupting the operation of the turbines. To accomplish this cleaning any of the tubes may be temporarily plugged without interfering with the action of those



Cross-Section of New Wheeler Compartment Condenser

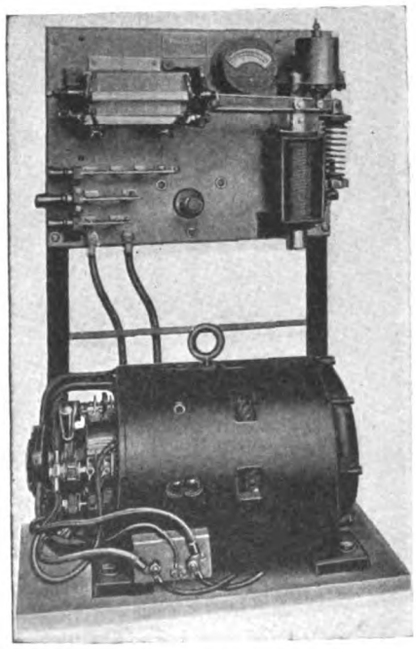
remaining. That the condenser be kept clean is essential in maintaining a high vacuum, which ultimately means low fuel consumption.

The condenser shown is divided into four compartments, each compartment being equipped with a set of valves to control the circulating water. To clean the condenser while the turbine is delivering full power, the operator simply shuts off the water from one compartment, removes the cover, cleans the tubes, replaces the cover, turns on the water again and then passes on to the next compartment.

Plastic Arc Welding Unit

A plastic arc welding unit has recently been supplied by the Wilson Welder & Metals Company, 2 Rector street, New York city.

The set is composed of a dynamotor, having a flat compound-wound generator maintaining a normal average of 35 feet at all loads, and a current-control panel. The Wilson principle of constant welding steel is utilized. To accomplish this, a small carbon pile, a



Wilson Welding and Metals Company Plastic Art Welding Unit

compression spring and a solenoid working in opposition to the spring are mounted on the control panel. The solenoid is in series with the arc so that any variation in the current will cause the solenoid to vary the pressure on the carbon pile. thus keeping the current at its adjusted value. Constant currents, ranging from 25 amperes to 175 amperes, are possible.

Various standard motor characteristics are available as a dynamotor unit: 110 volts, 220 volts, direct current; 220 volts, 440 volts, 60 cycle, two or three-phase alternating current. It may also be obtained in a gasoline (petrol) belt-drive without the motor.

Ship's Safe That Floats

One of the most novel exhibits at the recent Shipping, Engineering and Machinery Exhibition in London was that of a floating ship's safe such as used by the Netherlands Government for the conveyance of mails and valuables to and from their colonies. It automatically disconnects itself from a sinking ship, and while floating in the water sends up a rocket every hour for twelve hours. A sound signal is also given and a light shown for three months from the moment it leaves the ship.

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Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIP CONTRACTS

The France & Canada Steamship Company, 120 Broadway, New York, is reported to be in the market for six 10,000-ton tankers.

Freighter, Wilmington, Del.—The Pusey & Jones yard has laid the keel for a 2,750-ton freighter, 265 feet over all, for the Eastern Steamship Company, of Boston, Mass.

Tankers, Sparrows Point, Md.—It is reported that the Standard Oil Company has placed an order for two 20,000-ton tankers with the Bethlehem Shipbuilding Corporation.

Tankers, Newport News, Va.—The Standard Oil Company of New Jersey has just placed a contract with the Newport News Shipbuilding & Dry Dock Company for two 20,000-ton tankers.

Tankers, Gloucester City, N. J.—The Shell Transport Company of London has awarded a contract for four 8,500-ton tankers to the Pusey & Jones Shipbuilding Company, Gloucester City, N. J.

Wooden Boats, Norfolk, Va.—Norfolk Shipyards, Inc., capital $10,000, Benjamin Lowenberg, president, Norfolk; L. M. Bailey, secretary, Portsmouth, Va., has been organized to build wooden boats.

Tankers, Port Richmond, S. I.—The Staten Island Shipbuilding Company has received a contract for building two molasses tankers of 6,300 deadweight tons each from the American Sugar Refining Company.

Tankers, Camden, N. J.—Three 12,500-ton tankers have been ordered by the Standard Oil Company of New York from the New York Shipbuilding Company. They will be built at the Camden, N. J., yards.

Tankers, New York.—The Atlantic, Gulf & West Indies Steamship Lines, 11 Broadway, is in the market for six more bulk oil carriers of 9,600 tons deadweight in addition to those already under contract of construction.

Overhauling Destroyers, New London, Conn.—The New London Ship & Engine Company has purchased the United States destroyers Reid, Flusser, Preston and Lamson, and will overhaul them and install Diesel engines.

Big Tanker Programme.—The Scottish-American Oil & Transport Company of London, England, is forming a subsidiary company called Tankers, Ltd., with a capital of £5,000,000 and a big programme for building bulk oil carriers.

Schooners, Portland, Ore.—Two six-masted schooners of 4,150 deadweight tons each, built by the Peninsula Shipbuilding Company of Portland, Ore., have been sold to Grant Smith, of Portland, who will finish them for use in the lumber trade.

Colliers, Gloucester City, N. J.—The Pusey & Jones Company has a contract for fourteen colliers. Work was recently started there on three 8,500-ton tankers for French owners. Four other ships are on the ways, one of which is nearing the launching stage.

Schooners, Milton, Fla.—The Milton, Fla., shipyard recently purchased by Pascagoula, Miss., interests, is to finish the uncompleted schooner on the ways, and will make a specialty of building three-masted vessels for the coastwise and West Indies trade.

Steel Ships, Pascagoula, Miss.—The International Shipbuilding Company of Pascagoula, Miss., will finish one wooden ship now on the ways and discontinue building wooden hulls. The building of steel ships will continue at the plant without interruption.

Steamer St. Louis to Be Reconditioned.—The International Mercantile Marine, 9 Broadway, announces that the steamer St. Louis, now at the yards of W. & A. Fletcher, Hoboken, will be raised, reconditioned and take her place in the transatlantic trade.

Tankers, Chester, Penn.—The Merchant Shipbuilding Corporation, 165 Broadway, New York, has received an order from the Union Oil Company, of California, for two 10,000-ton bulk oil carriers. They will be built at the Chester, Penn., yards of the corporation.

Schooners, Milton, Fla.—The shipyard at Milton, Fla., recently purchased by Pascagoula interests, is soon to be opened and worked to its full capacity on three-masted schooners for the coastwise and West Indian trade. An uncompleted schooner now on the ways will be finished.

Concrete Boats, Norfolk, Va.—The Norfolk Construction & Marine Repair Corporation will erect a complete repair yard, with three railways and equipment for the construction of concrete barges and scows. The new concern has taken over the assets and holdings of the National Concrete Boat Company.

Freight Steamer, Quebec.—The Davis Shipbuilding Company has been awarded a contract by the Dominion Government for the construction of an 8,350-ton steel freight vessel, to be added to the Canadian merchant marine. Under construction is a large pontoon for the Canada Steamship Lines.

Repairing Former Virginian.—The former Allen liner Virginian, purchased in London a short time ago by the Swedish-American Line, Nielsen & Lundbeck, 24 State street, New York agents, has been renamed the Drottingholm, and will undergo extensive repairs in a British port, involving an expenditure of $100,000.

Converting Composite Ships, Savannah, Ga.—Four incomplete composite ships at the Terry Shipbuilding Company's yards, Port Wentworth, Savannah, are being converted into all-steel cargo carriers. Their length will be increased 45 feet, their tonnage increased from 3,500 to 4,200 tons, and oil substituted for coal as fuel.

Refrigerator Ships, Newark, N. J.—Among the contracts which the Submarine Boat Corporation, 5 Nassau street, New York, is putting through at the Newark Bay Yards is one for refrigerator ships for the International Products Company, 120 Broadway. Two of these, it is reported, are under way and will be of 1,400 gross tons.

New Steamship Company, Portland Me.—William H. Barton, formerly president and general manager of the Maine Coast Company, purchased the steamers Massasoit and Mohawk of that concern. He has organized a new company to be known as the Kennebec Steamship Company, maintaining two services, one to Portland and another to Jonesport, Me.

Tanker, Oakland, Cal.—The Standard Oil Company of California has contracted with the Moore Shipbuilding Company for an oil tanker with a capacity of 45,000 barrels, to be equipped with twin Diesel engines of 850 horsepower each of the type built by the Skandia Pacific Company. This will be the largest Diesel-driven ship every built in the United States.

Repairing Steamer, Oakland, Cal.—The Moore Shipbuilding Company has been awarded the contract for repairing the damaged stern of the steamer Howick Hall. The entire stern will be torn out and replaced, and the work will require at least two months. The damage resulted when several huge seas struck the vessel after she cleared the port for the Orient.

Cargo Ships, Long Beach Shipbuilding Company, Long Beach, Cal.—The keel for the second ship of the California & Mexico Steamship Company, San Francisco, has just been laid in the Craig Shipyards, Long Beach, Cal., and a third vessel has been ordered. The new ship will be the same as the Mazatlan, the first of the fleet being completed for the California & Mexico Steamship Company.

Repairing Steamers.—Contracts for repairs on five Shipping Board vessels have been placed as follows: The Ascoda, Vulcan Iron Works, Jersey City, N. J.; the Western City, Tebo's Yacht Basin, Brooklyn; the Lorain, Robins Dry Dock & Repair Company, Brooklyn; the Lake George, Marine Iron Works, Brooklyn, and the Lake Fackler, Arthur Tickle Engineering Company, Brooklyn.

Overhauling Destroyers, New London, Conn.—The New London Ship & Engine Company has purchased the United States destroyers Reid, Flusser, Preston and Lamson from the T. A. Scott Company, of New London, which recently purchased them from the Government. The company will give them a thorough overhauling and install Diesel engines, after which they will be sold to some foreign country.

Tankers, Chester, Penn.—Four tank steamers, each of 12,000 deadweight tons, have been ordered by the Atlantic, Gulf & West Indies Steamship Lines from the Sun Shipbuilding Company, of Chester, Pa. The company is planning a floating loading station about 85 miles south of Tampico, Mexico, which will enable two tankers to load at the same time. A 400-foot wooden pier is to be constructed to accommodate barges.

Steamship Companies, British Columbia, Canada.—The Vancouver Steamship Company, Ltd., and The Western Canada Steamships, Ltd., were recently incorporated under the laws of British Columbia by men representing eastern and western capital. Each will build an 8,300-deadweight tons standard steel freight carrier, at the yards of Coughlin & Sons, Vancouver, and will operate the ships on trans-Pacific routes out of Vancouver.

Changing to Oil Burners, San Francisco, Cal.—Work has begun at the Union Plant of the Bethlehem Shipbuilding Corporation,

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Ltd., on changing the 8,000 gross tons steamer Tahiti, of the Union Steamship Company, of Dunedin, N. Z., from a coal to an oil burner. Two other ships of the line will be overhauled and converted as soon as possible. It is believed that every vessel of the Union Line fleet, 59 in all, will be converted to oil burners.

Tankers, Mobile, Ala.—The Mobile Shipbuilding Company, it is announced by H. L. Brittain, president of the company, has received an order for between twenty and twenty-five bulk oil carriers from British interests. The specifications are not given, but it will take two years to complete the contract. The capacity of the plant will be largely increased, more men will be employed, and it is intended to turn out a 5,000-ton ship every month.

Cargo Ships and Tankers, Pensacola, Fla.—It is announced that a contract for building eight 9,000-ton ships and two 13,000-ton tankers has been made by the Government with the Pensacola Shipbuilding Company, the contract to start about April 1, when the company's original contract for ships for the Emergency Fleet Corporation has been completed. Information as to structural details of the ships and their engines has not been made public.

Converting Wooden Hulls, Seattle, Wash.—The wooden hull, Acadamea, one of the wooden freight carriers in Lake Union, near Seattle, Wash., has been purchased by Bruce C. Shorts, of Seattle, for $35,000. He will convert the craft into a steam schooner. Five hulls in Gray's Harbor, Wash., have been sold to the National Oil Company of New York, and will be taken to San Francisco to have machinery installed. The purchase price for the hulls was $350,000.

Passenger Steamers.—The New York & Porto Rico Steamship Company, 11 Broadway, New York, is planning to have two passenger ships, about 400 feet in length, built. The Red D Line, 82 Wall street, New York, is planning for two passenger ships of 5,000 tons and 14 or 15 knots speed, and the Munson Line, 82 Beaver street, New York, is also in line for two passenger steamers, built to meet tropical requirements. They will all be Ferris type boats, according to announcements.

Steam Schooner, Portland, Ore. — The Charles R. McCormick Lumber Company will stretch the keel of another big lumber schooner at the St. Helens Shipbuilding Company's yards as soon as the city of Everett, launched February 4, has made her trial trip. The new ship, like the City of Everett, will be equipped with engines developing 1,400 horsepower, with twin screws. It is understood that if a change in specifications will produce a more desirable vessel, plans for additional boats will be altered.

Freight Steamers, San Francisco, Cal.—The Moore Shipbuilding Company, at Oakland, Cal., has begun work on two 14,000-ton freight carriers for the Matson Navigation Company, San Francisco. They will carry 14,000 tons of sugar each, and 6,000-horsepower engines, with turbine geared propeller shafts, will develop a speed of 12½ knots loaded. The Matson Company is also working out details and specifications for a steamer to be the largest, fastest and most palatial passenger vessel on the Pacific.

The American Ship Building Company, Cleveland, has uncompleted orders for twenty vessels. Its subsidiary companies have the following orders for delivery early next spring: The Great Lakes Engineering Works, Detroit, will build seven; the Toledo Shipbuilding Company, four; the Manitowoc Shipbuilding Company, seven; the Saginaw Shipbuilding Company, six; the McDougall-Duluth Company, eight, and the Globe Shipbuilding Company, five. The McDougall-Duluth Company also has started construction of five other vessels for private concerns.

Freight Steamer, Seattle, Wash.—J. F. Duthie & Company have received a contract from the Coastwise Steamship & Barge Company for the construction of a 2,350-ton steel steamship for service in the coal, ore and lumber carrying trade in Puget Sound, British Columbia and Alaskan waters. The ship is to be delivered in June. It will be 220 feet long, 40 feet beam, with a molded depth of 21 feet. The engines will be aft, and she will have a loaded speed of 11 knots. She will be able to carry 1,500,000 feet of lumber. This is the first steel ship contracted for on private account in Seattle since the war ended.

SHIPBUILDING AND REPAIR PLANTS

Concrete Ship Plant, Mobile, Ala.—Fred T. Ley & Company, of Mobile, plan the purchase of the plant they are now operating from the Emergency Fleet Corporation.

Ship Repair Plant, St. Petersburg, Fla.—J. W. Attley, president, and J. B. White, secretary, have organized the Marine Ways Machine Company, Inc.; capital, $25,000.

Drydock, Locust Point, Md.—The Coastwise Shipbuilding Company is making plans for excavating for a dock 380 feet long and with a lifting capacity of 6,000 deadweight tons.

Drydock, Astoria, Ore.—The Port of Astoria Commission is having preliminary plans prepared for a drydock to cost about $1,000,000. R. R. Bartlett, Astoria, Ore, is engineer in charge.

New Shipyard, Portland, Me.—The National Oil Transport Company has been incorporated to build barges, ships, etc., with $1,000,000 capital, by R. I. Johnson, H. J. Smith and A. B. Farnham.

Drydock, Hoboken, N. J.—The first section of three which will make an 8,500-ton drydock being built at Bayonne by the W. & A. Fletcher Company, of Hoboken, has been launched. The dock when completed will cost about $800,000.

Drydock, St. Helenss, Ore.—The Charles R. McCormick Lumber Company has nearly completed its new dock at St. Helens. Tracks for the traveling cranes are to be laid from the dock to the plant of the St. Helens Shipbuilding Company.

New Shipyard, Kittery, Me.—The Boston Maritime Corporation has been incorporated, with $2,000,000 capital, to engage in shipbuilding in all its branches. The incorporators are Harry W. Foster, George W. Burnham and Elmer J. Burnham.

New Shipyard, Baltimore, Md.—The Globe Shipbuilding & Dry Dock Company (noted in February issue) is preparing plans to include construction of drydocks, ship berths, railroad switches and various buildings. Estimated cost about $5,000,000.

Drydock, Brooklyn, N. Y.—The fourth section of a Todd Shipyards Corporation 9,000-ton floating drydock will be put in operation this spring. The dock will be 432 feet long, 114 feet wide and will accommodate ships 500 feet in length and 26 in draft.

Drydock, New London, Conn.—It is planned to build a drydock in connection with the port development. The Mayor of New London has appointed a committee to act in conjunction with civic bodies and labor organizations in support of the project.

Drydock, Sparrows Point, Md.—The Bethlehem Shipbuilding Corporation will lay the keel for a floating drydock in April. The work is being delayed pending the completion of pontoons now being constructed. When completed the drydock will be capable of receiving a 400-foot ship of 6,000 deadweight tons.

Drydock Company Merger, Providence, R. I.—The Lord Drydock Company has made an offer to the Marine Dry Dock & Engineering Company to take over the plant and continue the business of the latter company, with the object of consolidating and strengthening the position of the plants in Providence and New York City.

Ship Yard to Be Naval Base, San Diego, Cal.—The Scofield Engineering Company's shipyard at San Diego, Cal., has been turned over by the Shipping Board to the Navy Department. It will be converted into a fleet repair base, accommodating vessels up to 3,000 tons. Rear Admiral R. W. Wells will be in charge.

New Shipyard, Norfolk, Va.—The Norfolk Construction & Marine Repair Company is to erect one of the most complete repair yards in its district, comprising three railways of 500, 1,200 and 3,000 tons, respectively, and ways and equipment for the construction of concrete barges and scows. The company has about half a mile of water front on the southern branch of the Elizabeth River, and about 60 acres of land. Work will begin soon. Col. M. A. Butler, at present in charge of the Army Base at Norfolk, will assume control of the new concern on March 15.

Ship Repair Plant, Boston, Mass.—J. L. Byrne, 53 State street, Boston, is planning a ship repair plant to occupy about 14 acres at the entrance to Chelsea Creek. Two 10,000-ton drydocks (convertible into one 12,000-ton dock), one 8,000-ton, one 3,200-ton sectional floating dock and one 500-ton floating drydock are to be constructed, with wet basins and a complete equipment of shops. Wharves, piers and buildings will be largely of concrete. Mechanical equipment of shops to be electrically driven. Dredging has begun and the project is expected to be completed in about nine months.

PORT IMPROVEMENTS

Wharf, Pittsburg, Cal.—The city has voted to issue $40,000 in bonds to build a wharf. Information from city clerk.

Dredging, Cleveland, Ohio.—United States Engineer's Office, Federal building, Cleveland, is having plans prepared for dredging in Huron harbor; about $35,000.

Underwater Bracing, Baltimore, Md.—The Superintendent of Lighthouses will receive bids for installing new underwater bracing at York Spit Light Station, Virginia. Information on application.

Repairing Pier and Breakwater, Dunkirk, N. Y.—The United States Engineer's Office, 540 Federal building, Buffalo, is having plans prepared for repairing the west pier and breakwater, Dunkirk harbor.

Terminal, South Boston, Mass.—The Eastern Terminal Company, J. E. Starr, 103 Federal street, New London, Conn., has purchased site and plans to build terminal storehouse; cost, about $2,000,000; engineer not selected.

Dredging, Galveston, Tex.—Bids will be received until March 11 by the United States Engineer's Office, Trust Company building, Postoffice and Tremont street, for dredging Houston Ship Channel. Information on application.

Municipal Pier, Baltimore.—Bancfort Hill, president of the Harbor Board, is working out details of plans for new bulkhead and municipal pier in the Locust Point section. Several acres of land are being reclaimed for this purpose.

Docking and Repairing Light Vessel, Charleston, S. C.—Bids will be received by the Superintendent of Lighthouses, Charleston, S. C., for docking and repairing Brunswick Light Vessel No. 84. Information on application.

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Stone for Jetties, San Francisco, Cal.—The United States Engineer's Office, Washington, D. C., will soon receive bids for furnishing stone for jetty structures at Humboldt Harbor and Bay. Former bids rejected. Noted in February issue.

Rock Supply, New Orleans.—The Superintendent of Lighthouses, New Orleans, La., will soon receive bids for furnishing and delivering in place around Horn Island Light Station, Mississippi, about 400 tons ballast or other approved rock.

Dredging, Norfolk, Va.—The United States Engineer's Office, War Department, Washington, D. C., has let contract for dredging in Pagan River, Norfolk, to W. H. French Dredging & Wrecking Company, Arcade building; cost, $6,806.

Heating Piers, New York.—Fruit importers in New York are endeavoring to have piers on which food products are handled supplied with heat. They assert that large quantities of perishable foodstuffs are lost every year through freezing on the piers.

Dredging Harbor, San Diego, Cal.—The War Department has awarded a contract for dredging more than 1,500,000 cubic yards from the various shoal areas in the harbor of San Diego, Cal., to the United States Dredging Company, San Francisco.

Lighthouse Tender, New Orleans, La.—The Superintendent of Lighthouses, New Orleans, La., will receive bids for furnishing labor and material to completely construct, equip and deliver 65-foot twin-screw lighthouse tender Aster. Information on application.

Dredging, Hudson River Channel, N. Y.—The United States Engineer's Office, 39 Whitehall street, New York, has let contract for dredging in Hudson River Channel, New York harbor, to F. E. Jones, 17 Battery Place, New York, for about $375,000.

Repairing Pier, Santa Monica, Cal.—The city will receive bids for repairing municipal pleasure pier, to have creosoted wooden piles to support the deck, etc. About $75,000 available. Olmstead & Gillellen, Hollingsworth building, Los Angeles, engineers.

Dredging and Rock Removal, Hudson River, N. Y.—Bids will be received until March 11 by the United States Engineer's Office, Army building, 39 Whitehall street, New York, for dredging and rock removal in Hudson River, N. Y. Information on application.

Army Piers, Norfolk, Va.—The City of Norfolk has taken over, under contract with the War Department, a portion of the Army Supply Base, and is operating Pier No. 2. The piers have a draft of 40 feet at low tide with ample storage space and railroad service.

New Harbor, Stockton, Cal.—The City Council has had preliminary plans prepared for a new harbor, involving widening the channel from 200 to 1,250 feet, building wharves, etc.; cost estimated about $4,000,000. S. A. Judd, Stockton, engineer; A. L. Banks, city clerk.

Repairs to Light Vessel, Charleston, S. C.—Bids will be received by the Superintendent of Lighthouses, Charleston, S. C., until February 26 for manufacturing one new cast iron condenser body and main engine back columns, for Frying Pan Shoals Light Vessel No. 94. Information on application.

Municipal Dock, Vancouver, Wash.—Detailed plans for the proposed municipal dock for Vancouver, Wash., have been made public. The dock will be 1,245 feet long and 200 feet wide. It is planned to cover 800 feet of the dock, which will cost about $365,000. The first unit will cost about $150,000.

Ship Terminal, Berkeley, Cal.—The Pacific Port Terminal Company, F. F. Cresson, Jr., 50 Church street, New York City, engineer, plans to build a ship terminal at Berkeley, Cal., to include piers, bulkheads, sheds, one-story warehouse, railroads, etc., on water front. Estimated cost about $2,000,000.

Piers and Warehouses, Marshfield, Ore.—Coos Bay authorities are planning locations for port docks and warehouses. The Pony Inlet district, just west of the North Bend, is regarded as the most available site, but will require a vast amount of dredging to make a channel deep enough for maneuvering vessels.

Piers, Staten Island, N. Y.—The Board of Estimate, New York City, has increased the appropriation for dredging and the construction and equipment of proposed piers at Stapleton, Staten Island. Former bids above amount allotted. Murray Hulbert, Commissioner of Docks, Pier A, New York City, in charge.

Terminal, Vancouver, B. C.—The Dominion Government has completed the purchase of 750 feet of water frontage for a terminal site. A new pier to be erected this year will be just west of the Great Northern dock. The Government dock with equipment, including site, will cost $4,400,000, it is announced.

Sea Wall, Paris Island, S. C.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., has plans, and will soon receive bids, for building 2,062 lineal feet of concrete sea wall and other concrete work at the marine barracks. Estimated $86,000; $10 deposit required for plans and specifications.

Piers, Providence, R. I.—Tentative plans are being developed by Jonathan Starr, New London, Conn., representing the Eastern Terminal Corporation, for three 1,000-foot piers, a terminal warehouse and trackage connection with the New York, New Haven & Hartford Railroad at Harbor Junction, South Providence, R. I.

Channel, Marshfield, Ore.—The State of Oregon has had preliminary plans prepared by A. Powers, Oregon Agricultural College, Corvallis, for building channel 4,000 feet long, 30 feet wide, 6 feet deep at low water, 60 feet deep at highest point to connect Isthmus Inlet and Beavers Slough; estimated cost about $125,000.

Deepening Newark Bay.—The New Jersey Port Development Association has been organized, with Calvin Tomkins, former Commissioner of Docks, New York City, as president, for the purpose of deepening Newark Bay and converting the waste meadow land along the bay into sites for manufacturing concerns and railroad terminals.

Terminals, Pascagoula, Miss.—The city of Pascagoula intends to spend between $75,000 and $85,000 on terminals, and the order for piling for a 500-foot wharf, which will cost $40,000, has already been given. A spur track of the Louisville & Nashville Railroad will run from the wharf to the yards of the International Shipbuilding Company.

Bunkers, Portland, Ore.—The Commission of Public Docks has authorized G. B. Hegardt, chief engineer for the commission, to prepare plans and specifications for the erection of bunkers at the St. Johns terminal, suitable for the handling of coal, sulphur or other similar material in bulk. The bunkers will probably be built on Pier 5 of the terminal.

Dredging, Detroit, Mich.—The United States Engineer's Office, Railroad building, has let contract for dredging and rock excavating in Livingston Channel, Detroit River, involving 98,000 cubic yards of limestone rock, and 345,000 yards place measurement of earth to the Empire Engineering Company, Inc., 6 Church street, New York, at $600,760.

Piers, Camden, N. J.—Under a bond issue of $500,000 work on two piers at Camden, N. J., will begin as soon as weather conditions permit. Contracts have been let. The northern pier will accommodate ships 600 feet in length, and the southern pier ships of 480 feet length. The plans also call for a big marine terminal, the entire project to involve $3,000,000.

Terminal, Long Island City, N. Y.—The new State barge canal terminal at Nott avenue and the East River has been taken over from the contractors by Edward Walsh, New York State Superintendent of Public Works, who intends to throw the terminal open to manufacturers and business men in the district for use as a public dock as soon as the men necessary to operate it can be obtained.

Channels, Long Beach, Cal.—J. F. Collins, City Harbor Engineer, has recommended that the city widen and deepen channels and turning basin, extend jetties and construct wharves; estimated cost $2,496,390. Two alternative plans suggested, one, not including extension of jetties, to cost $1,443,350; the other, not including widening two channels, to cost $1,904,500. H. C. Waughop, city clerk.

Wharfage and Storage Space, New Orleans, La.—The Secretary of War has approved the application of the Director General of Railroads for the use of 900 linear feet of wharfage and 50,000 square feet of storage space at the Army Supply Base, New Orleans, La., for the barge line operated by the Mississippi-Warrior River Section, Division of Inland Waterways, United States Railroad Administration.

Submarine Base, Key West, Fla.—Contract for constructing the Key West Submarine Base, involving building of breakwater and a number of timber piers, dredging, etc., has been awarded to the Snare & Triest Company, of New York, partly on a unit price and partly on a lump sum basis. Total estimated cost, $1,700,000. The Bowers Southern Dredging Company, Galveston, has the contract for dredging.

Port Improvement, New Orleans, La.—The Board of Commissioners of the Port of New Orleans intends to expend about $14,500,000 in improvements in 1920. This includes $5,000,000 for construction of new wharves, improvements on existing wharves and betterment of port facilities; $2,000,000 will be used in rat-proofing wharves, wharf approaches, landings and warehouses, and $7,500,000 on completion of the Industrial Canal. The work of rat-proofing has just begun under urgent orders from the Commission.

Fuel Oil Stations.—Thirteen fuel oil stations have been located by the Shipping Board. One at St. Thomas, Virgin Islands, of 110,000-barrel capacity, and another at Brest, France, of 165,000-barrel capacity, are now in operation. Others at Ponta Delgada, Azores, Cape Verde Islands, Bizerta, Algiers, Constantinople, Colombo, Shanghai and Manila are expected to be ready by April 1. At Honolulu a 110,000-barrel supply is to be ready by June 1. At Durban, South Africa, a 165,000-barrel capacity, and at Sydney, N. S. W., a supply not yet determined are expected to be ready by July 1.

Piers, Seattle, Wash.—The Seattle Port Commission's Smith Cove Pier B, said to be the most gigantic of the world's ocean piers, was to be opened about February 15. Chief Engineer George F. Nicholson, who designed Pier B, announced that its superstructure or wharf is 90 percent completed, while the decking is progressing rapidly. The pier is 2,54$ feet long and 267 feet wide, and with ease will be able to handle 1,800,000 tons a year. This pier represents an expenditure of $2,500,000. Although it will not be ready for regular operation until May 1, Capt. Inar A. Pederson, traffic manager of the Port Commission, has ordered that the first ship should start loading the middle of February.

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FOREIGN MARITIME MATTERS

Breakwater, Port Maitland, N. S.—The Department of Public Works, Ottawa, plans to build a stone-filled native timber crib breakwater at Port Maitland. Cost, about $200,000. C. E. W. Dadwell is the district engineer.

Docks, Dairen, Manchuria.—Extension of a quay line to make possible berthing of 15,000 tons of shipping and the handling of 12,000,000 tons of cargo a year is planned by the Manchuria Railway Company. The work will extend over a period of ten years.

Drydock, St. John, N. B.—Machinery and power equipment for the plant of the St. John Dry Dock & Shipbuilding Company, at Courtenay Bay, N. B., are arriving and being stored preparatory to beginning work, which will start as soon as weather conditions permit.

The Southern Steamship Company, Ltd., of Newcastle-on-Tyne, England, has sold its fleet of 11 vessels, aggregating 76,000 tons, to the Western Counties Shipping Company, of Cardiff, Wales, for £1,900,000. The buyers recently purchased the fleet of the Moor Line, of Newcastle.

Passenger Steamer, Belfast.—The new steamer which Harland & Wolff are building at Belfast for the Aberdeen Line passenger service to Australia is to be a geared turbine oil burner of 12,000 tons. A second vessel of this type is to be built for the same company at once.

New Steamship Company, Antwerp.—Plans are announced for the founding of a new steamship company, to be known as the Compagnie du Sud Franco-Belge, of Antwerp, which will operate vessels under the Belgian flag between Antwerp and ports of Brazil and Argentina.

J. C. Gould & Company, Ltd., Cardiff, Wales, have issued details of a plan for the formation of a new company, with a capital of £3,000,000, in £1 shares, to acquire the Griffiths-Lewis Steam Navigation Company, Ltd., and the Dulcia Steam Shipping Company, Ltd., of Cardiff.

Enlarging Danzig Harbor, Germany.—Danzig harbor is to be dredged and enlarged at an expense of 2,500,000 marks. On the east of the Kaiser dock a quay is being built 1,000 meters long. Warehouses and a harbor for steamers are projected on the west side of the Vistula River.

Shipping Merger, Cardiff, Wales.—The Hansen Shipping Company, Ltd., of Cardiff, is to acquire the controlling interest in Graham's Navigation & Collieries, Ltd. T. C. Graham, Henry J. Thomas and Arthur W. Graham will retire from the Graham directorate as soon as the transfer is completed.

Ships Needed, Brazil.—Dr. Cincinnato Braza, Minister of Agriculture, Industry and Commerce, announces that it will be necessary for Brazil to spend an enormous amount of money in the near future for ships, and that at least 500,000 tons of river and ocean steamships will be needed by Brazil within the next generation.

German Shipping Lines Combined.—The Deutsche-Levante Linie and the Hamburg-America Linie have made an agreement according to which the assets of the former are to pass to the latter as a whole without liquidation. The service is to be continued under the name of Deutsche-Levante Linie and under the same flag.

Harbor Improvements, Kingston, Ont.—The Dominion Government plans to dredge outer entrance of harbor works and enlarge basin to 25 feet. The project includes a complete layout railway trackage and yards, dock and grain elevator, with a capacity of 2,400,000 bushels. W. A. Bowden, Department of Railways and Canals, Ottawa, Ont., engineer in charge.

Canada to Aid Shipyards.—The Dominion Government has decided to make loans to Pacific Coast shipyards up to 75 percent of the cost of each ship under construction. The Chilberg Ship Company of Victoria, B. C., will build four wooden sailing schooners, the Government financing the project up to $175,000 a ship, with the company furnishing $75,000.

Oil Bunkering, Liverpool.—The Mersey Docks and Harbor Board will open the "Parkhill and Dingle Bank Estates" at the south end of the dock estate, for the erection of oil storage tanks for bunkering and other purposes at Liverpool. The tanks will have pipe lines to oil berths in the Herculaneum Branch Dock, where vessels can use their own pumps to discharge to the tanks.

Repairing Quay Walls, Glasgow, Scotland.—The Clyde Trustees are preparing to undertake a good many minor improvements, and also to repair the damage caused to quay walls in different parts of the harbor. Work has already begun on the Anderson Quay. The estimated cost of reconstruction is figured at £50,000. Work will soon have to be undertaken at the Plantation Quay on the opposite side of the river.

Motor Vessels, Copenhagen, Denmark.—The East Asiatic Company, of Copenhagen, has decided to build 17 vessels of from 10,000 to 13,000 tons deadweight each, to be completed in the next three or four years. The largest will have two 3,200-horsepower Diesel engines, giving a speed of 14 knots and will be ready for trial this year. If this ship is satisfactory, it is stated, motor vessels of up to 15,000 to 16,000 tons and 6,000 horsepower will be built.

Vickers & Company are making extensions to their Yarrow shipyard, to enable them to overtake the large programme of merchant shipbuilding. The company is now building two Cunard liners, two for the Commonwealth Government, a Donaldson liner, an oil tanker and other similar vessels, and is preparing three large new berths. It has also taken over the yard of the Ferro-Concrete Ship Construction Company, which has abandoned the construction of concrete vessels.

New Shipyard, Kiel, Germany.—The new Commonwealth Shipyard at Kiel, which embraces the former Imperial yard, will be under the Ministry of the Treasury and handled by a joint stock company in which all the shares are owned by the State. The yard has begun to build merchant vessels, and four 8,800-ton turbine-driven ships are to be built for the Rob M. Sloman Company, while the Commonwealth Commisioner has ordered 20 fishing steamers and a number of Baltic and North Sea fishing cutters.

Fishing Fleet, France.—Announcement is made that the French Government has appropriated the sum of 200,000,000 francs to be spent for the reorganization of the deep sea fishing industry of that country, the project including the construction of heavy oil-engined auxiliary craft and improvements of harbors and harbor facilities. One harbor, specifically is to be constructed at Lorient-Keroman, which is intended to be one of the largest and most efficient in the world. The vessels to be built for this fleet are to be, generally, of oil motor and sailing vessel type. No steam-driven crafts are included.

Enlarging Helsingfors Harbor, Finland.—According to plans of the Helsingfors City Council the present 3,000 meters (1 meter = 3.28 feet) of quays is to be lengthened to 27,000 meters, the cost being estimated at something like 100,000,000 Finnish marks. The project embraces a free harbor for South Busholmen. Helsingfors South Harbor will be used for Baltic shipping and passenger traffic. North Harbor will accommodate local traffic, while Sornas Harbor will be used for export, especially timber and lumber and their products. It is also planned that a part of Sveaborg will be incorporated as a part of Helsingfors Harbor.

Oil Fuel Installation, Aberdeen, Scotland.—The Ministry of Munitions is to erect a steel oil storage tank 70 feet in diameter, 30 feet deep, capacity 3,142 tons, with outlet pipes, to Mearns Quay, River Dee, and Albert Quay, Tidal Harbor. A concrete retaining wall, 524 feet long and 10 feet high, will surround the site.

Workman, Clark & Company Yards, Belfast.—A new agreement as to the future of Workman, Clark & Company's shipyards at Belfast has recently gone into effect. Sperling & Company, bankers, of London, now hold the majority interests in the firm on behalf of the Northumberland Shipbuilding Company, which now virtually owns the yard. Sir George Clark and Mr. C. E. Allan are managing directors of the shipbuilding and engineering departments, respectively, but Mr. Frank Workman and others of the directors have retired from the firm. A statement that the new owners of the company expect to extend the work is incorrect. It is understood that Sperling & Company, who control the Northumberland Shipbuilding Company, Ltd.; Doxford & Company, and the Workman-Clark concern, will also purchase the shipyard and works of Swan, Hunter & Wigham Richardson, Ltd., of Wallsend.

SHIPPING DEVELOPMENTS

New Steamship Service, Boston.—The New England Maritime Corporation intends to operate a steamship service between Boston, Los Angeles and San Francisco. There will be monthly sailings.

Freight Line, Philadelphia.—A new freight line between Philadelphia and Antwerp has been established by the Cunard Steamship Company, making the fourth route of Cunard steamers running from Philadelphia.

Baltimore Far East Service.—Baltimore business men express pleasure over the announcement that the Green Star Steamship Corporation will establish service between Baltimore and China and Japan ports.

Soliciting Freight Agent, Boston.—To meet the demands of increasing business the International Mercantile Marine Company has created at Boston the position of soliciting freight agent, and T. E. Carpenter has been appointed to fill it.

Towage Company, Bath, Me.—The Kennebek Towage Company has been formed, with Fred N. Boston, of Gardiner, president; Rupert H. Baxter, Bath, vice-president; Thomas S. Gibbons, Bath, treasurer and general manager; Walter S. Glidden, Bath, secretary.

Harriman Company Buys Line.—The Harriman Company, 120 Broadway, has acquired stock control of the Coastwise Transportation Company of Boston. It is understood this deal represents an investment of $6,500,000. The Coastwise Company is credited with owning nine ocean-going steamships.

Freight Service, Portland, Me.—Announcement has been made that the White Star-Dominion Line plans a regular freight service between Portland and the Mediterranean ports. The Lowrance Company also announces the beginning of the operation of a fleet between Portland and Hamburg, Germany, and between Providence and Manchester, England.

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